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PROGRESS LETTER FOR PERIOD

February 1, 1964 through March 1, 1964

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MONTH OF THE
CONTRACT

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CHANGE DETECTOR

[redacted]

30 March 1964

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The twentieth month of the program has been devoted to the initiation of the checkout and evaluation phase of the program. The trial assembly of all of the registration components which mount on the base plate, was completed during this month. A checkout and alignment of the optical portion of the registration system was completed. The focusing capability of the optics was determined by backlighting a resolution pattern at each of the film planes and observing the resolution of the image at the CRT plane with a microscope. Adjustments were made in the positions of the scale factor computation arms to keep the system in best focus as the scale factor was varied throughout the total range. The adjustment was made first by calculating the required positions of lens and magazine for a given magnification and measuring with a precision dial indicator the actual positions for best focus. Once the magazine travel end points were established, the magazine drive servo

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amplifiers were temporarily connected to permit the magazines to follow as the scale factor was varied throughout the total range. When the scale factor computation arms were properly adjusted, adequate focusing was achieved. Alignment of the dove mirror assembly was also performed to obtain a rotation of the image about the center of the optical axis as the assembly was rotated. The excursions of all of the other moving assemblies were checked to determine that no interference problems existed.

Prior to disassembly, components requiring accurate alignment which fasten to the base plate were drilled for the insertion of dowel pins to facilitate the final assembly. The registration mechanism was then dismantled and the base plate was painted.

A bench checkout of the film drive portion of the film magazines was performed. The frame advance, slow film slew, and manual and automatic pressure plate release mechanisms were operated. Satisfactory performance was obtained from each of the mechanisms. The existing film magazines and film drives will be used for checkout of the remainder of the system until the new magazines incorporating the fast film slew capability are completed.

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Fabrication of the final versions of the 108 volt regulated backlight power supply and the dynamic focus circuitry for the magnetically focused scanning CRT was completed. The bench checkout of the

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scanning CRT; synchronizer and raster generator; vertical, horizontal and position deflection amplifiers; and associated power supplies has been discontinued because of a need for some of the components in the trial assembly of the entire registration mechanism. The checkout of this portion of the equipment will be included as part of the overall system checkout.

FUTURE PLANS

Efforts will continue on the checkout and evaluation phase of the program.

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PROGRESS LETTER FOR PERIOD

January 1, 1964 through February 1, 1964 THE 19th MONTH OF THE CONTRACT

CHANGE DETECTOR

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20 February 1964

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The nineteenth month of the program has been devoted to the completion of the design phase and the initiation of the checkout and evaluation phase of the program. With the completion of fabrication of the registration assemblies and mounting base, installation of the units for a trial assembly was started this month. The control rods, dove mirror assembly, lens drive assembly, control rod servomechanisms, scale factor drive and associated rod guide assemblies have been mounted onto the main base plate. Once the initial optical and mechanical alignment of the registration mechanism is achieved, the assemblies which fasten to the base plate will be pinned to facilitate accurate remounting of these units for final assembly.

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A bench checkout of the final version of the scanning crt and associated equipment has been initiated. The equipment involved in the checkout includes the crt; synchronizer and raster generator;

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vertical, horizontal and position deflection amplifiers; 17.5 kv anode supply; -100 v and +2000 v bias supplies; and the system power programmer which supplies the power to the system in the proper time sequence. The magnetic focus and dynamic focus circuitry will also be incorporated into this checkout upon completion of fabrication.

In connection with the design policy of providing protective circuitry for the critical portions of the system, a sweep failure protection circuit has been developed. When coupled to the output deflection amplifiers, this circuitry will automatically cut-off the electron beam of the scanning crt in the event of a failure in the raster generation circuitry. The cut-off of the electron beam will prevent burning of the crt phosphor due to the stationary high intensity focused spot. A crt bias delay function has also been incorporated into the system. If a primary power failure occurs due to a premature removal of the power plug or for some other reason, this circuit will immediately cut off the electron beam of the crt, thus preventing damage to the expensive tube.

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The development of two reference power supplies which supply the plus and minus DC reference voltages required by the positioning potentiometers in all of the servo loops has been completed. These supplies operate from the $\pm$ 30 volt regulated main system power

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supplies and produce a precisely controlled ± 20 volt reference voltage. Care has been taken in the design of these supplies to minimize the effect of load variations which would cause cross-talk in the servos.

FUTURE PLANS

Efforts will continue on the checkout and evaluation phase of the program.

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PROGRESS LETTER FOR PERIOD

December 1, 1963 through January 1, 1964 THE 18th MONTH OF THE CONTRACT

CHANGE DETECTOR

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[redacted] 3 February 1964

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The eighteenth month of the program has been devoted to bringing the design phase of the program to near completion. Fabrication of the registration mechanism assemblies has been completed. Fabrication and machining of the base on which the assemblies will be mounted is 95 percent complete. A trial assembly of the registration components will be initiated as soon as the base is completed. A coarse optical alignment will be performed when this trial assembly is completed.

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The choice of the [redacted] 5-inch crt has necessitated a re-design of the focus and dynamic focus circuitry. A high resolution coil which combines the focus and dynamic focus functions is being purchased to meet the magnetic focus requirements of the tube. Circuitry capable of driving this focus coil is currently under development.

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The high voltage power supply which supplies the anode voltage for the crt has been modified to meet the requirements of the new tube. The output voltage has been changed from 15 kilovolts to 17.5 kilovolts. This will further decrease the spot diameter of the tube and increase the brightness at a given beam current. The unit has undergone tests at this higher output voltage and the regulation, ripple, and stability have been determined to be adequate for the system.

The investigation into techniques for compensation of backlight variations during the registration process has led to the conclusion that the complexity involved in performing the inversion function electronically does not warrant its use. The stability, linearity, and frequency response requirements make the circuit complexity such that more simplified methods of backlight regulation are more practical for the system. A D.C. regulated voltage supply is currently being designed to supply the backlight. The output voltage will be a nominal 108 volts supplying the 115 volt backlight. When the lamp begins to age, the supply will increase slightly in voltage to maintain a relatively constant brightness from the lamp. Short term variations caused by line voltage fluctuations will be cancelled out through the use of the regulated supply.

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Fabrication of the rack mounted -100 volt and +2000 volt crt bias supplies has been completed. Fabrication of the rack mounted phototube high voltage and 28 V control power supplies is nearly complete.

Fabrication of the servo amplifiers which control the registration functions has been completed.

FUTURE PLANS

Efforts will continue on the completion of the design phase of the program and initiation of the checkout and evaluation phase.

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PROGRESS LETTER FOR PERIOD

November 1, 1963 through December 1, 1963 THE 17th MONTH OF THE CONTRACT

CHANGE DETECTOR

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[redacted] 20 December 1963

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The seventeenth month of the program has been devoted to a continuation of the design phase of the program. Design and fabrication of the registration mechanism is nearly complete. Fabrication of most of the assemblies is complete. The remaining assemblies in fabrication and the percent of completion are shown as follows:

Magnification Computation Arms and Drive Assemblies	90 percent
Reference Film Magazine	75 "
Comparison Film Magazine	50 "
Phototube and Backlight Insertion Mechanism	50 "
Mounting Base	25 "

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Fabrication of the entire registration mechanism is estimated to be 90 percent complete at this stage. It is anticipated that installation and coarse alignment of the components in the registration mechanism will take from one to two weeks. Final alignment will be made when the system becomes operable.

[redacted]

Two types of high resolution 5 inch cathode ray tubes have been evaluated with respect to resolution and brightness on the change detector breadboard system. The first tube is the [redacted] and the second is a [redacted] tube. Utilizing the high voltage and bias supplies of the breadboard system, which were not designed to meet the vigorous requirements of these high resolution tubes, a readout resolution of approximately 45 line pairs per millimeter was obtained from both tube types when the USAF test target was scanned. It is anticipated that the high voltage and bias supplies designed for the console will increase the measured resolution capability of the crt. Brightness measurements have indicated a problem area associated with the [redacted] The maximum beam current obtainable from this tube type was approximately 10 microamperes, while a beam current of over 30 microamperes is obtainable from the [redacted] Since the light emitted from similar phosphors is directly proportional to the beam current for a constant anode voltage, the brightness of the [redacted] is more than three times that of the [redacted] The signal-to-noise ratio obtained at the phototube output from the light emitted by the [redacted] was considered to be marginal when films of high base density were scanned. The choice of the [redacted] requires a modification to the focus and dynamic focus circuitry since this tube employs magnetic focusing. The focus for the [redacted] is electrostatic. The modification is warranted, however, by the increased performance of the [redacted] tube.

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STATINTL

The high voltage power supply which supplies the anode voltage for the scanning crt has been received. The unit is currently undergoing tests to determine if it meets the regulation, ripple, and stability requirements specified prior to purchase.

Fabrication of the rack mounted bias, and power supplies which mount beneath the display monitors, has been initiated. These include the phototube high voltage supplies, the -100 volt and +2000 volt crt bias supplies, and the 28 volt unregulated power supply. The purchased high voltage crt anode supply and the regulated +30 and -30 volt main system regulated power supplies also mount in the racks beneath the display monitors.

Development of the spot wobble circuitry for raster line suppression of the display monitors is nearly complete. A problem was encountered during the development of the circuitry which was caused by a beating of the harmonics of the raster frequency with the 20 megacycle spot wobble rate. The beat ~~rate~~ caused ~~was~~ an objectionable herringbone pattern to be displayed on the monitor crt. This problem has been eliminated by applying the horizontal synchronizing pulses, which stabilize the horizontal scan of the monitors, to the spot wobble oscillator such that the 20 megacycle rate is started at exactly the same point in each scan line of the monitor. With this stable integral relationship established between the scanning rate and the spot wobble rate no herringbone pattern is obtained.

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An electronic technique to perform the inversion function for minimization of backlight variations is being investigated. A breadboard version of the circuitry is currently being fabricated.

Checkout of the final version of the display generating circuitry including the synchronizer, raster generation, deflection and positioning circuitry is nearly complete.

FUTURE PLANS

Efforts will continue on the final portion of the design phase of the program.

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PROGRESS LETTER FOR PERIOD

October 1, 1963 through November 1, 1963

THE 16th MONTH OF THE CONTRACT

CHANGE DETECTOR

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28 November 1963

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The sixteenth month of the program has been devoted to a continuation of the design phase of the program. The console has been moved into the laboratory darkroom and the applicable control functions on the control panel have been coupled to the change detector breadboard. The various monitor mode control switches have been checked out, as well as the video gain control functions. A breadboard version of the area selection joy stick has been installed together with the area blow-up controls.

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[redacted]

Design and fabrication of the registration mechanism is continuing. Assemblies which have been released for fabrication and the percent of completion are shown as follows:

Positioning Rod Servos	100 percent
Dove Mirror Assembly	99 "
Mirror and Field Lens Assembly	99 "
CRT Mount Assembly	100 "
Rod Follower Assemblies	100 "

[redacted]

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Mask and Half-Mask Assembly	95 percent
X, Y Lens Drive Assembly	99 "
Nutation Wedge Drive Assembly	99 "
Movable Mirror Assembly	95 "
Density Wedge Servo	90 "
Cross-Hair Mechanisms	70 "
Magnification Computation Arms and Drive Assemblies	25 "
Reference Film Magazine	25 "
Comparison Film Magazine	10 "
Phototube and Backlight Insertion Mechanisms	10 percent

Detailed design of the mounting base for the registration mechanism has been initiated. Designs of the raster size control servo and joy-stick assemblies will be initiated after receipt of the registration mechanism. Fabrication of the entire registration mechanism is estimated to be 75 percent complete at this stage.

STATINTL

[redacted]

Development of the video switching and output circuitry for the left monitor has been completed. Fabrication of the final version of this circuitry has been initiated. Development of the spot wobble oscillators for the monitor raster line suppression function has been initiated. The requirement for raster line suppression is that

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a signal of approximately 60 volts at a rate of 20 megacycles or greater be applied to the deflection plates of the spot-wobble monitor CRT's. A modification to the existing design of the phototube video preamplifiers to enable the same preamplifier to be used to supply the video signals during readout and the correlation signals during automatic registration. This eliminates the need for two separate phototube preamplifiers for each channel.

Fabrication has been initiated on the 25 servo amplifying assemblies required for registration. All of the servo power amplifiers are purchased units. In addition to the power amplifier each assembly contains a variable gain preamplifier and a 60 cycle modulator. The completed assemblies will be mounted on the mechanism base assembly adjacent to each respective servo motor.

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The investigation of techniques for compensation of backlight variations is continuing. The use of Hall effect multipliers for the inversion function has been discarded because of an oscillatory problem which developed when they were used in this application. Other electronic multiplication configurations are currently being investigated.

DISCUSSION

With the completion of the initial layout for the control panel, discussions were held with company human factors engineers to deter-

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mine if any problem areas existed in the layout. As a result several modifications have been incorporated into the panel. Figure 1 shows the new control panel layout. Nearly all of the control functions have remained the same, only the positions have been rearranged. The two handed operation of area selection and area blow-up have been separated farther so that the left hand may operate the blow-up controls without interferring with the right hand operation of the area selection joy-stick. The six monitor mode gain, level and rate control knobs have been separated farther apart to prevent interference problems when adjusting the controls. The five focus controls have also been moved to a less congested area. The mirror image arrangement of similar controls on the left and right side has been eliminated. Where possible, similar controls on the left and right side are now located in the same relative position. One new control function called "manual registration" has been added to the panel. This control function has been provided to allow the operator to reactivate the manual registration controls for a fine adjustment of the two images after automatic registration if required when viewing blown-up areas because of distortion between the films. When this control is not activated following automatic registration the manual alignment controls will remain inoperable and any accidental movement of these controls during the change readout process will not disturb the registration.

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FUTURE PLANS

Efforts will continue on the design phase of the program.

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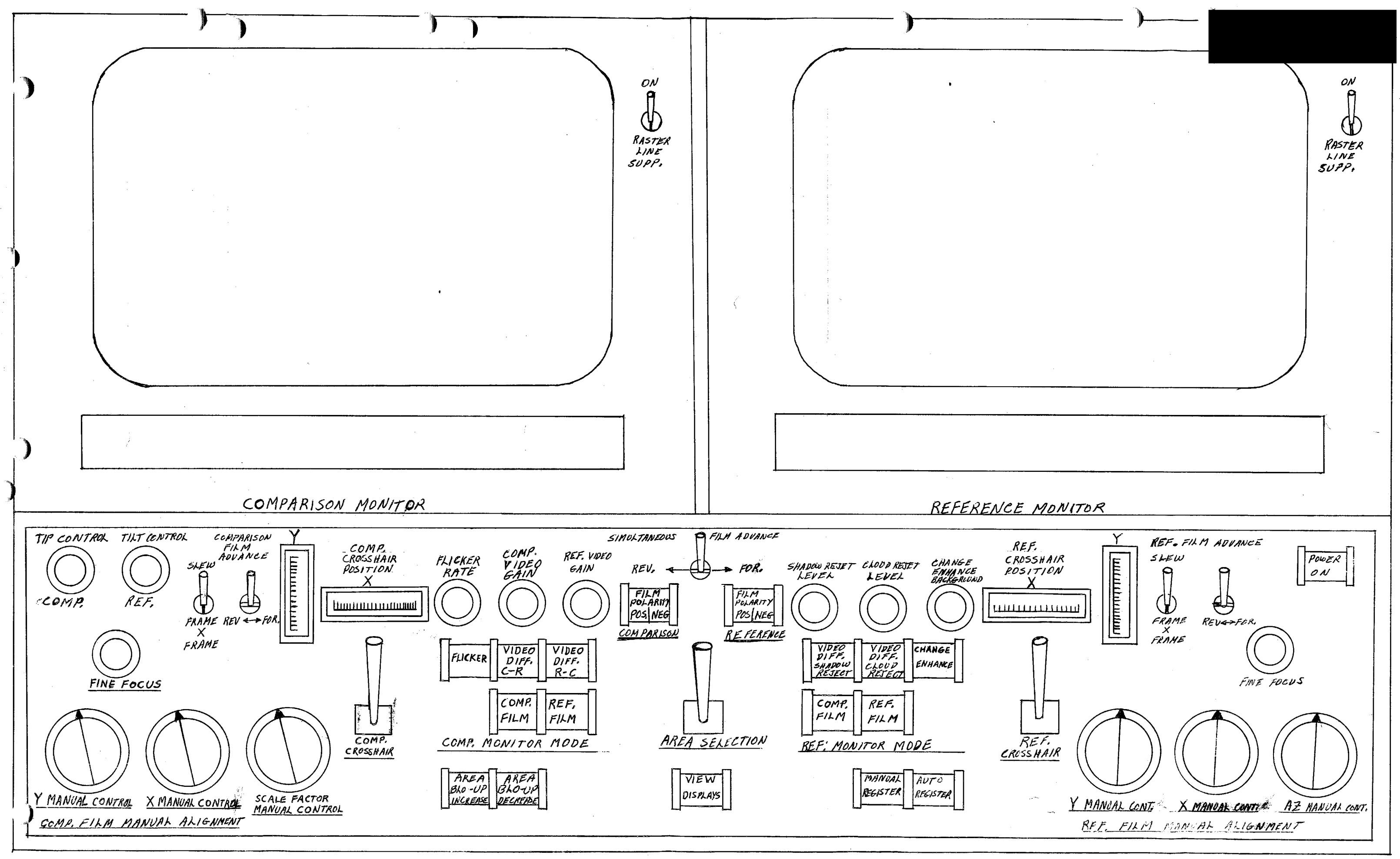

Figure 1 - Modified Panel Layout

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PROGRESS LETTER FOR PERIOD

September 1, 1963 through October 1, 1963

THE 15th MONTH OF THE CONTRACT

CHANGE DETECTOR

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20 October 1963

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Approved For Release 2002/01/02 : CIA-RDP78B04747A002600010044-5

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The fifteenth month of the program has been devoted to a continuation of the design phase of the program. With the completion of the console cabinet efforts in this area have been concentrated on the control panel. The control panel has been drilled and available components have been mounted utilizing the tentative layout discussed in last month's report. Upon completion of the mock-up of the control panel, discussions will be held with human factors engineers

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to determine the modifications required in the layout for improved operator performance when using the controls.

Design and fabrication of the registration mechanism is continuing. Assemblies which have been released for fabrication and the percent of completion are shown as follows:

Positioning Rod Servos	95 percent
Dove Mirror Assembly	99 "
Mirror and Field Lens Assembly	95 "
CRT Mount Assembly	100 "

[redacted]

STATINTL

Rod Follower Assemblies	95 percent
Mask and Half-Mask Assembly	90 "
X, Y Lens Drive Assembly	95 "
Nutation Wedge Drive Assembly	80 "
Movable Mirror Assembly	40 "
Density Wedge Servo	20 "
Cross-Hair Mechanisms	20 percent

Detailed designs of the film magazines, phototube and backlight assemblies, phototube and backlight insertion movement, and the magnification computation arms and drive assemblies are continuing. Major assemblies yet to be designed include, the mounting base for the entire registration mechanism, the raster size control servo which accomplishes the electronic blow-up, and the joy-stick assemblies. Fabrication of the entire registration mechanism is estimated to be 60 percent complete at this stage.

STATINTL [redacted]

Development and checkout of the breadboard automatic gain control circuitry has been completed. The checkout was performed on the breadboard change detector using a test film with different base densities. Base density variations up to 2 were successfully accommodated by the automatic gain control circuitry with negligible change in the video output. The automatic gain control is accomplished by sampling the video output signal and converting it to an equivalent DC voltage. This voltage is then amplified and fed back to the

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phototube power supply control. Since the gain of the phototube is dependent on the bias voltage applied, this negative feedback loop provides the necessary automatic gain function. Fabrication of the final version of this circuitry is currently underway.

Checkout of the final plug-in version of the video amplifier and video difference circuitry has been completed. This unit is ready for insertion into the console. Checkout of the entire display generation system has been initiated. This includes the synchronizer, sweep generators, horizontal and vertical deflection amplifiers, and horizontal position amplifier. Development of the video switching and output circuitry necessary to drive the left side monitor has been initiated. The functions to be controlled for the left side include the reference display, the comparison display, video difference-reference minus comparison, video difference-comparison minus reference, and the flicker display. Switching between these various functions is accomplished by video switching relays with the selected output being supplied to the video driver. Generation of the flicker display is accomplished by utilizing a bi-stable flip-flop to alternately switch between the comparison video and the reference video. Triggering for the bi-stable flip-flop is derived from the 60 cycle/sec vertical synchronizing pulses. The 60 cycle rate is divided by 12 in a fixed monostable divider. The resultant 5 cycle/sec rate is then fed to a variable monostable multivibrator which divides the trigger signal by from 2 to 10 depending on the control setting.

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The output of this circuit is used to trigger the bi-stable flip-flop generating a controllable flicker rate. Switching of the two video signals is always accomplished during the vertical blanking interval of the video signal due to the time locked switching action of the dividers. Switching transients and flashes are thereby eliminated from the display monitor. Logic circuitry to control the push switches on the control panel is also under development.

STATINTL Two [redacted] 14 inch monitor tubes with special deflection plates for raster line suppression have been received. Raster line suppression is accomplished by introducing a sinusoidal voltage on to the deflection plates at a rate of twenty megacycles or greater. This causes a wobble of the spot as it is scanned across the face of the tube. The result is a blending of the raster lines as the image is displayed with no loss of resolution.

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DISCUSSION

One of the requirements for automatic registration of imagery in the change detector is that the correlation gain must remain relatively constant. Variations in backlight intensity must, therefore, be kept to a minimum during the correlation process. Long term variations in the light intensity must also be minimized. Short term variations in the intensity which occur during the correlation phase can be eliminated by the use of a regulated power supply for the backlight. Long term intensity variations associated with the

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brightness decay of the lamp as it ages must be accommodated by other methods. Any long term loss of brightness will be automatically compensated by the density wedge servo. The use of this servo to minimize this variation results in a loss of dynamic range capability necessary to accommodate the base density variations in the imagery to be correlated. A technique to handle both long and short term backlight variations is currently being investigated. A block diagram illustrating the approach is shown in Figure 1. The phototube adjacent to the backlight is used to sample the variations in light intensity from the lamp. The variations are amplified and fed to circuitry which inverts the signals. The phototube sensing the correlation function also senses the variations due to the backlight. Since the correlation output is multiplied by the fluctuation of the backlight, cancellation of the fluctuation can be achieved by multiplication of the inverse of the fluctuation. This can be accomplished by mixing the outputs of the correlation phototube and the inversion circuitry. The output then will contain only the correlation function. A combination of Hall effect multipliers is being investigated to perform the inversion function. The main problem in obtaining cancellation by this method is in developing circuitry capable of long term stability since any drift will have the same effect as lamp aging in the other approach and will reduce the dynamic range of the density wedge servo.

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FUTURE PLANS

Efforts will continue on the design phase of the program.

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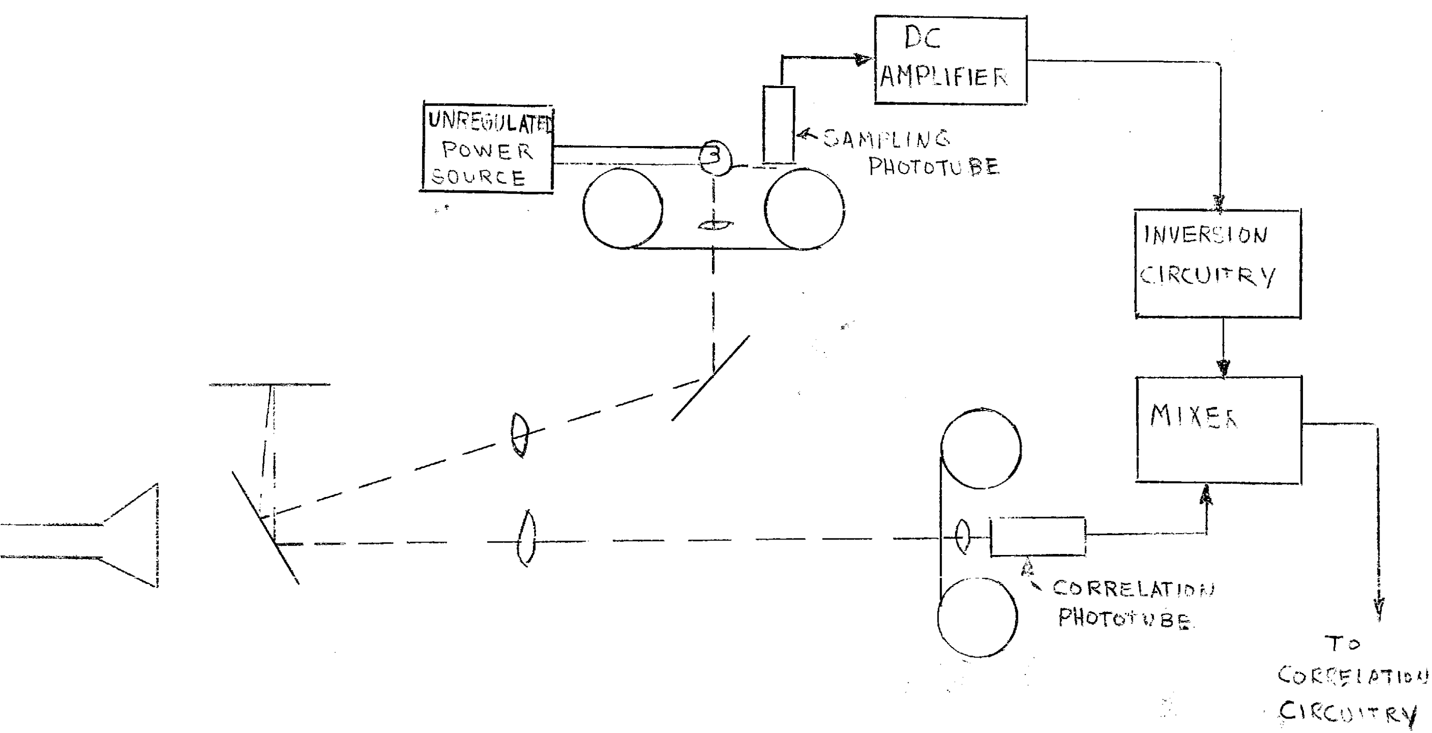

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FIG. 1 - BACKLIGHT COMPENSATION APPROACH

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PROGRESS LETTER FOR PERIOD

August 1, 1963 through September 1, 1963 14th MONTH OF THE CONTRACT

CHANGE DETECTOR

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[redacted] 20 September 1963

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STATINTL

PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The fourteenth month of the program has been devoted to a continuation of the design phase of the program. Fabrication, painting and assembly of the console cabinet has been completed. Prior to final assembly the base was cut and locating pins were inserted into one side. The separate sections were then bolted together to again form one integral unit. This method of separating the cabinet into two units for shipment has been determined to be satisfactory to meet the requirements of structural rigidity and ease of separation and assembly. The cabinet has been moved from the assembly area in the Engineering Shop to the Engineering Lab where the installation of the various components in the console will be performed. Installation of the monitors into the sliding racks has been completed.

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Design and fabrication of the registration mechanism is continuing. Assemblies which have been released for fabrication and the percent of completion are shown as follows:

[redacted]

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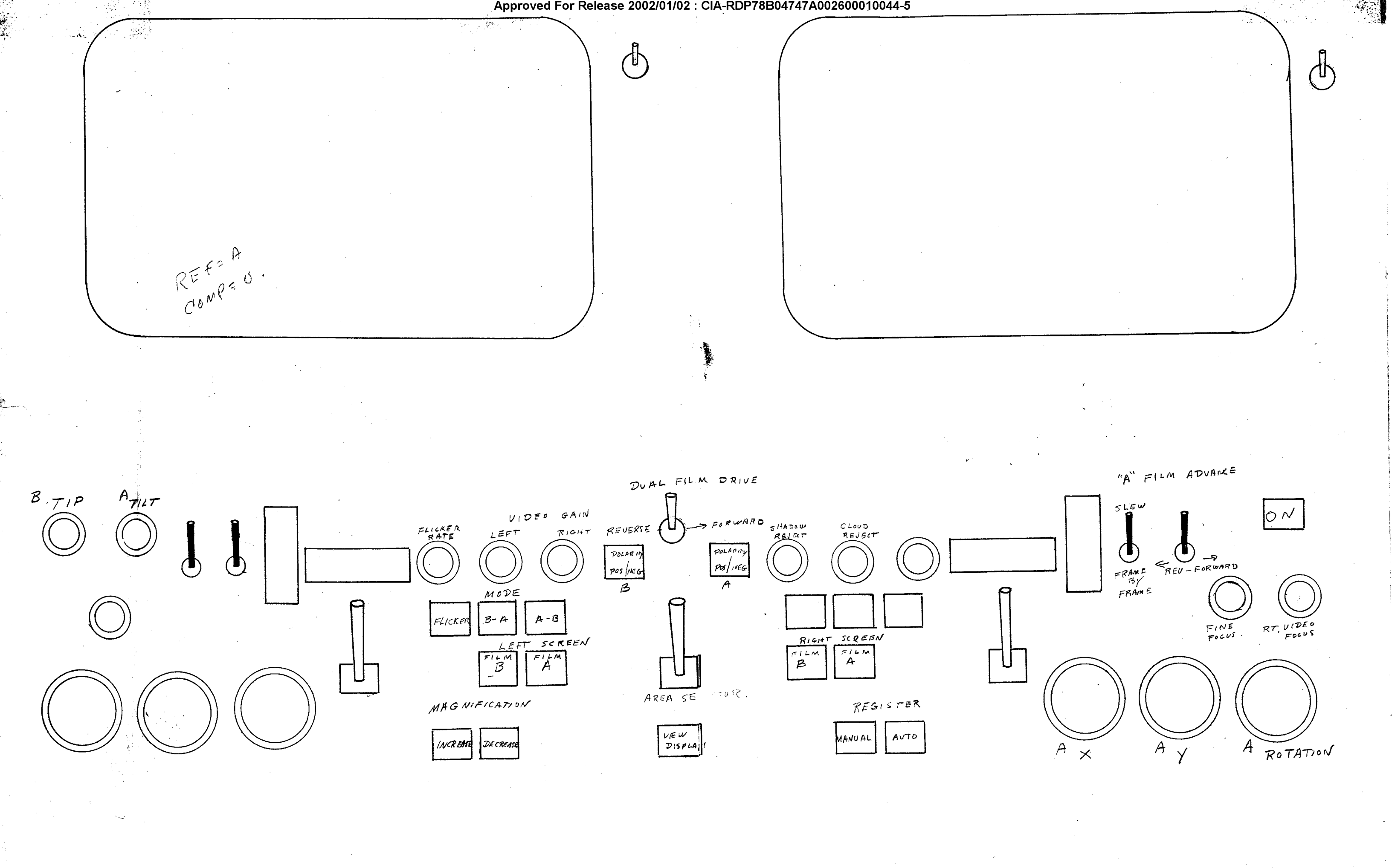
Positioning Rod Servos	95 percent
Dove Mirror Assembly	99 percent
Mirror and Field Lens Assembly	90 percent
CRT Mount Assembly	100 percent
Rod Follower Assemblies	95 percent
Mask and Half-Mask Assembly	80 percent
X, Y Lens Drive Assembly	50 percent
Nutation Wedge Drive Assembly	20 percent

Detailed designs of the film magazines, phototube and backlight assemblies, cross-hair mechanism, and density wedge servo are continuing. Fabrication of the entire registration mechanism is estimated to be 45 percent complete at this stage.

STATINTL

[redacted]

Development of the automatic gain control circuitry for the video system is nearly complete. Checkout of this circuitry will be performed on the breadboard change detector. Fabrication of the video amplifier and difference circuitry for the console has been completed. Checkout of this portion of the system is currently underway. Fabrication of the vertical and horizontal deflection amplifiers for the scanning CRT has been completed. With the completion of this assembly, the entire scanning raster generation system for the CRT is now complete.


REF = A
COMP = U.
B TIP
A TILT
FLICKER RATE
VIDEO GAIN
LEFT
RIGHT
DUAL FILM DRIVE
REVERSE
FORWARD
POLARITY POS/NEG
B
A
SHADOW REJECT
CLOUD REJECT
"A" FILM ADVANCE
SLEW
ON
FRAME BY FRAME
REV – FORWARD
FINE FOCUS
RT. VIDEO FOCUS
MODE
FLICKER
B-A
A-B
LEFT SCREEN
FILM B
FILM A
RIGHT SCREEN
FILM B
FILM A
MAGNIFICATION
INCREASE
DECREASE
AREA SE
VIEW DISPLAY
REGISTER
MANUAL
AUTO
A X
A Y
A ROTATION

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DISCUSSION

An initial layout of the console control panel has been completed and is shown in Figure 1. As can be seen, the layout of the various controls is nearly symmetrical, with those pertaining to the reference film on the right side of the panel and those pertaining to the comparison film on the left. Controls which apply equally to both films are located in the center section. The manual registration and alignment controls for the reference film are the X, Y, azimuth and fine focus controls. Those for the comparison film are the X, Y, scale factor, and fine focus controls. While the tip function is applied to one film magazine and the tilt function is applied to the other film magazine, both controls are located on the comparison film side of the panel for ease of adjustment. Film advance controls for each film are located on the respective sides of the panel. The films may be either advanced or reversed on a frame-by-frame basis or when using panoramic type films, they may be slewed in either direction. Simultaneous movement of the films on a frame-by-frame basis is accomplished by utilizing the film advance control located in the center of the panel. Control of the cross-hairs located in front of each film plane is accomplished by joysticks on each respective side of the control panel. Meters which show the X and Y position of each cross-hair are adjacent to each joystick. The film polarity controls which enable the

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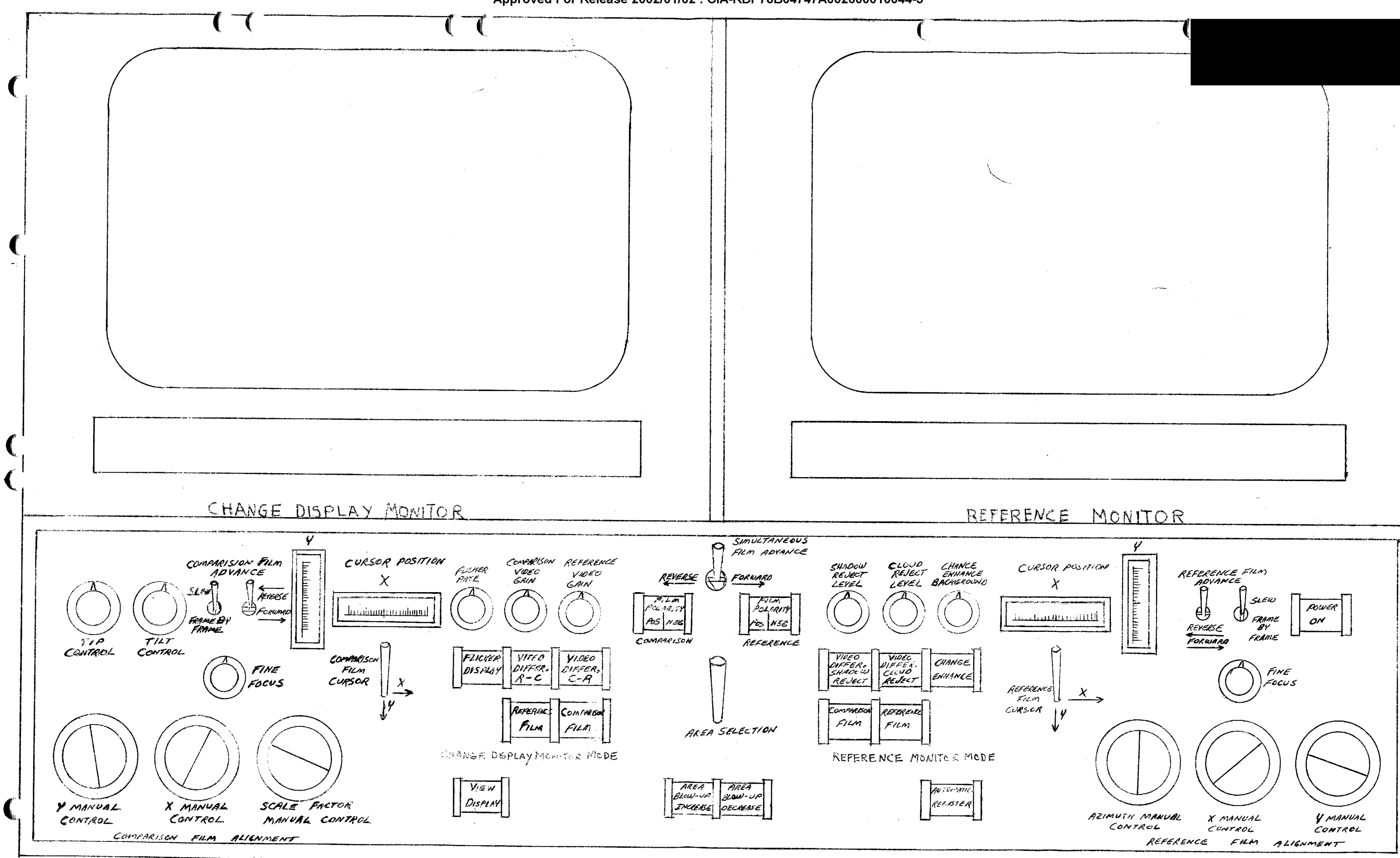

FIG 1. CONTROL PANEL LAYOUT

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monitors to present the correct polarity for viewing are located on their respective sides of the panel.

A single control is required to initiate the system automatic registration mode. All other switching in this mode is done automatically. When automatic registration has been completed the view displays indicator is activated. This indicates that the registered images of the two films are available for presentation on the two monitors. The presentations displayed on the change display, or left monitor, are controlled by the change display monitor mode group of switches. The presentations available to this monitor are: video difference; reference minus comparison; video difference comparison minus reference; flicker; reference scene; and comparison scene. Controls for adjusting these various functions are located above the switch group. The reference monitor mode group of switches, similarly controls the presentation displayed on the reference, or right, monitor. The presentations available to the reference scene monitor are: video difference shadow reject, video difference cloud reject, change enhance, reference scene, and comparison scene. The associated controls are located above the switch group. The area selection and "blow-up" controls which control both scenes simultaneously are located in the center of the panel.

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FUTURE PLANS

Efforts will continue on the design phase of the program.

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PROGRESS LETTER FOR PERIOD

July 1, 1963 through August 1, 1963 13th MONTH OF THE CONTRACT

CHANGE DETECTOR

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20 August 1963

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STATINTL

PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The thirteenth month of the program has been devoted to a continuation of the design phase and display data processing phase of the program. Fabrication of the console cabinet components has been completed and a trial assembly has been successfully accomplished. Painting of the entire cabinet is nearly complete. Preparation of the surfaces to insure a good paint bond included an acid etching process, several coats of primer, and then the finish coat. It is intended that the entire cabinet will receive a preliminary finish coat. When all the mechanisms and components have been installed and the system has been evaluated, it will be painted with a final finish coat prior to shipment to touch up any scratches that may have been accummulated during that time.

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[redacted]

Since the decision has been made to separate the console into two units for shipment, a method of joining the two base and cabinet sections with a minimum of effort has been developed. The console

[redacted]

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will be separated at the point where the cabinet containing the registration mechanism and the cabinet containing the monitors meet. The base will be cut at this point and dowel pins inserted in one side to insure proper realignment. Once proper alignment is achieved the two base sections and the two cabinet assemblies can be bolted together. Access holes will be cut in the tops of the base sections so that the bolts may be tightened from above. It is felt that once the console is reassembled after shipment, a negligible loss in overall rigidity of system will occur.

Design and fabrication of the registration mechansim is continuing. Assemblies which have been released for fabrication and the percent of completion are shown as follows:

Positioning Rod Servos - 90 percent

Dove Mirror Assembly - 96 percent

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Mirror and Field Lens Assembly - 80 percent

CRT Mount Assembly - 50 percent

[redacted]

Rod Follower Assemblies - 90 percent

Mask and Half-Mask Assembly - 20 percent

Detailed designs of the x,y lens drive assembly for automatic registration, nutation wedge drive assembly are nearly complete. Detailed design of the film magazines and phototube and backlight assemblies is continuing. Detailed design of the cross-hair mechanism and density wedge servo has been initiated. Fabrication

[redacted]

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of the entire registration mechanism is estimated to be 30 percent complete at this stage.

Testing and evaluation of the breadboard correlator has been completed. The purpose of constructing this breadboard was to check out the half-mask concept of azimuth and scale factor registration; to determine a satisfactory method of setting the correlation gain; and to develop and check out search and match point detection circuitry and other circuits associated with the registration process. To these ends the breadboard correlator has been determined to be a useful and necessary investment.

Development of circuitry to provide an automatic gain control for the video system to supply a constant video level to the monitors regardless of the raster size of the scanning CRT and the film contrast is continuing. A plug-in version of the video amplifier and

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difference circuitry is under fabrication. It will be mounted along with the rest of the video system in the compartment beneath the control panel. Fabrication of an assembly containing the vertical and horizontal deflection amplifiers and the horizontal raster position amplifier for the scanning CRT has been initiated. This assembly will be mounted along side of the CRT housing and shield assembly since it must be located in close proximity to the CRT yokes.

[redacted]

A 15 KV high voltage power supply capable of meeting the voltage

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regulation requirements imposed by the higher resolution speci-
STATINTL fication is being developed [redacted] Delivery
STATINTL is expected by the end of September. A trip to [redacted]
STATINTL [redacted] was made by two
STATINTL [redacted] engineers during this reporting period to discuss the high resolution CRT requirements and the spot-wobble monitor tube requirements. As a result of this meeting an order has been placed for a
STATINTL [redacted] five inch CRT. This developmental type tube will have a maximum spot diameter of .00065 inches. A one-half inch thick faceplate is incorporated into this tube to insure a flatness commensurate with the resolution requirement. A four to six month delivery schedule is anticipated for the tube. [redacted] 14 inch
STATINTL cathode ray tubes with a special set of electrostatic deflection plates to accomplish the spot-wobble function for raster line
STATINTL suppression have also been ordered. These tubes are identical to the existing monitor tubes except for the addition of the extra plates. Receipt of these tubes is expected in about one month.

[redacted]

Electronic circuitry currently under construction or previously fabricated on plug-in cords for the console is shown as follows:

- synchronizer
- raster generators
- deflection amplifiers
- video amplifier
- match point detector
- coordinate storage

[redacted]

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The overall completion of fabrication for the system electronics is estimated to be 60 percent.

FUTURE PLANS

Efforts will continue on the design phase of the program.

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PROGRESS LETTER FOR PERIOD

June 1, 1963 through July 1, 1963

12 th MONTH OF CONTRACT

CHANGE DETECTOR

[redacted]

20 July 1963

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The twelfth month of the program has been devoted to a continuation of the design phase and display data processing phase of the program. Fabrication of the console cabinet is continuing. Construction of the framework and base has been completed. Machining of the base for mounting of the registration mechanism and drilling of the jack pad insertion holes has been completed. Fabrication of the monitor housing assemblies has been initiated. Cutting and installation of the outside panels has also been initiated. Upon completion of fabrication of all the components of the cabinet, the cabinet will be completely assembled. When a proper fit of all the components is assumed the cabinet will be disassembled and all of the components will be painted separately.

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Design and fabrication of the registration mechanism is continuing. Fabrication of the two manual rod control servo assemblies is nearly complete. Fabrication of the dove mirror system has been initiated. The detailed design of the correlator mask and half-mask assembly has been completed and fabrication of the unit has been initiated. Detailed design of the x and y

[redacted]

STATINTL

lens drive assembly for automatic registration has been started. Design of the film magazines, phototube and backlight assemblies is continuing. Construction of the entire registration mechanism is estimated to be 15 percent complete at this stage.

Tests conducted on the breadboard correlator to determine the dynamic range of the correlation gain adjustment system have been completed. The unit will accurately set the correlation gain for films having a combined base density variation of 4. This result was achieved by inserting neutral density filters between the two films being correlated in the breadboard. The loop was closed through the phototube and variable density wedges and the output of the phototube was observed with various neutral density filters inserted. A density of 4 (transmissivity ratio of 10,000 to 1) was the minimum level to which the wedge servo would track and give a constant phototube output for correlation. Further tests including film contrast as well as base density will be conducted on the console during the evaluation phase of the program to determine the correlation dynamic range capabilities of the system.

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[redacted]

Development of circuitry to provide an automatic gain control for the video system to supply a constant video level to the monitors regardless of the raster size of the scanning CRT and the film contrast, is continuing. A new layout of the video amplifier and video difference circuitry which conforms to the form factor requirements of the console has been developed and installed in the breadboard change detector. Several circuit modifications have resulted in a further improvement in the video signal-to-noise ratio presented to the

[redacted]

monitors.

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DISCUSSION

Receipt of the contract add-on to increase the readout resolution of the system to 50 line pairs per millimeter has made necessary some modifications to the overall program plan as well as the system design. In order to meet the new resolution requirements the following tasks will be added to the program:

1. Selection of a scanning CRT with a spot size of approximately .0006 inches.
2. Selection of a 15KV high voltage supply for the CRT with a voltage variation of no greater than $\pm$ .5 volt.
3. Development of improved dynamic focus circuitry for the CRT including raster size information as well as raster position information.
4. Tighten the optical and mechanical tolerances of those components in the registration system which affect the resolution.
5. Provide a vernier focus adjustment on the scale factor positioning mechanism which will be controlled from the control panel.

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In addition to the above tasks the requirement for suppression of the raster lines in the monitors makes necessary a procurement of 14 inch cathode ray tubes with special deflection plates to accomplish the vertical spot wobble. Development of high frequency oscillator circuitry to drive the deflection plates is also necessary.

[redacted]

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The above tasks will be integrated into the existing design phase and display data phase of the program and will not be set up as a separate phase.

FUTURE PLANS

Efforts will continue on the design phase and display processing studies of the program. Generation of the interim report will be initiated.

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PROGRESS LETTER FOR PERIOD

May 1, 1963 through June 1, 1963

11th MONTH OF CONTRACT

CHANGE DETECTOR

[redacted]

15 June 1963

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The eleventh month of the program has been devoted to a continuation of the design phase and the display data processing phase of the program. Fabrication of the console cabinet has been initiated. All of the structural framework is being welded for increased rigidity. The entire cabinet enclosure will sit on a steel base plate which is currently being fabricated. Casters will be attached to the base plate for ease of mobility of the unit. Leveling pads are also being attached to the base plate to level the console once it is in the proper position. The overall maximum dimensions of the console with the desk top removed are 104.5 inches in length, 80 inches in height, and 30 inches in depth. It is possible to break the console into two units, one containing the registration system and the other containing the display portion of the system, if it is required for shipment. If this is necessary, however, the overall structural rigidity and vibration sensitivity will be increased. The installation complexity will also be increased since interconnections will be required between the two units.

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Detailed design of the registration system is continuing. Fabrication of the manual control rod servos has been initiated. Detailed design of the dove mirror assembly and the crt shield and mount assembly is nearly complete. A detailed design of the correlation mask assembly has been initiated. Design of the film magazines and phototube and backlight assemblies is continuing. Specification control drawings for the nutation wedges, mirrors and condensing lenses have been completed and sent to various suppliers for quotes. Most of the servo motors and amplifiers required to drive the various registration functions have been received. The size 11, 15, and 18 servo motors to be used in the system have been set up in a breadboard mock-up in order to check their compatability with the amplifiers. The performance has been determined to be adequate for the system.

Modification of the breadboard correlator to provide the automatic sequencing function has been completed. It has been satisfactorily determined that the breadboard correlator can set the proper correlation gain level, and proceed to an automatic registration in x, y and azimuth with a set of aerial photographs inserted. Tests are currently underway to determine the dynamic range capabilities of the correlation gain adjustment mechanism. Other tests using various sets of imagery will be conducted to determine the registration capabilities of the breadboard in order to obtain more data for the console design.

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A modification to the phototube circuitry of the breadboard change detector has resulted in an increased signal-to-noise ratio of the video signal fed

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to the video amplifiers and shadow rejection circuits. The increased signal-to-noise ratio has been achieved by reducing the bandwidth of the phototube circuitry to a value comparable with the bandwidth of the crt P-16 phosphor response. Noise components generated by the phototube above this usable bandwidth have been eliminated, thereby increasing the signal-to-noise ratio.

A push switch operated motor driven raster size control to obtain an area blow-up capability has been installed in the breadboard change detector. This assembly is similar to that which will be installed in the console. Circuitry necessary to reduce the intensity of the crt as the raster size is decreased to eliminate phosphor burning has also been installed in the breadboard. Development of circuitry to vary the high voltage supplied to the phototubes for automatic gain control of the video signals is continuing.

Circuitry now completed on plug-in cords for the console includes: the synchronizer, crt raster generation circuitry, and portions of the match point detection and coordinate storage circuitry.

DISCUSSION

A portion of the system which has not previously been described is the back-light density wedge servo which sets the correlation gain. Figure 1 shows a block diagram of this servo system. Many of the registration components of the system have been left out for simplicity. The closed loop operation of the servo is as follows. The output d-c voltage of the phototube pre-amplifier is compared to the d-c reference voltage in the summing circuit. If a difference exists between these voltages, an error signal is fed through

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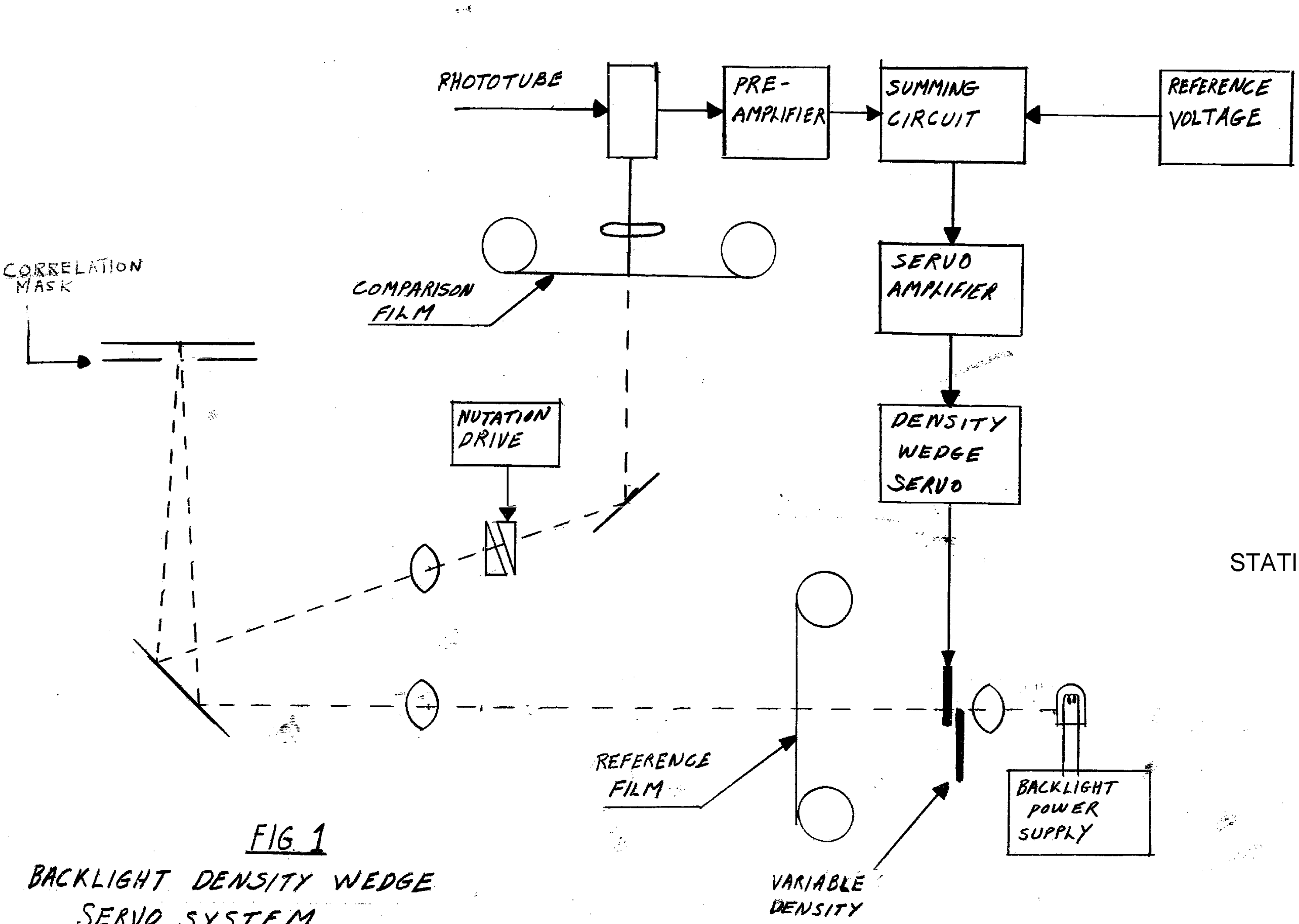

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FIG 1

BACKLIGHT DENSITY WEDGE SERVO SYSTEM

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the servo amplifier to the density wedge servo which positions the variable density wedges. The variable density wedges allow more or less light to be passed through the system as required. The amount of light received by the phototube is a function of the product of the transmissivity of the two films. It is also a function of the overlap area of the imagery being correlated, since the correlation mask reduces the aperture as the overlap area decreases. Thus, when film frames with different transmissivities are inserted in the system, or if a change in the overlap area occurs, the light striking the phototube will change, causing the servo to operate.

Operation of the backlight density wedge servo is placed in the operational sequence of the system following manual registration of the two scenes. If the two scenes are manually registered to a position at or near their correct matchpoint, the light that strikes the phototube will also be determined by the correlation function of the two scenes. In order to minimize this undesirable effect, the nutation wedges are kept running during the operation of the backlight servo system.

The optimum reference voltage setting has been determined by setting the variable density wedges to the maximum density position and adjusting the reference voltage until the phototube output is approximately 50 times the dark current of the phototube. This provides maximum dynamic range of the wedge servo, while allowing a 50 to 1 signal-to-noise ratio for the correlation function.

FUTURE PLANS

[redacted]

Efforts will continue on the design phase of the program.

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PROGRESS LETTER FOR PERIOD

April 1, 1963 to May 1, 1963

SIXTH MONTH OF CONTRACT

CHANGE DETECTOR

[redacted]

STATINTL

15 May 1963

STATINTL

[redacted]

Approved For Release 2002/01/02 : CIA-RDP78B04747A002600010044-5

[redacted]

STATINTL

PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The tenth month of the program has been devoted to a continuation of the design phase and the display data processing phase of the program. Detailed design of the console cabinet is nearly complete. Fabrication of the control panel and its associated components box has been completed. The complete unit is designed to be inserted into the desk top of the console. The desk top, in turn, is removable from the main console body to permit passage through a 30 inch door. The control panel is hinged at the top for ease of access to the components beneath the panel. A metallic green has been chosen as the most mutually acceptable color for the cabinet. The desk top will be formica.

Detailed design of the console registration system is continuing. The manual rod control servos are in the final design stage preparatory to being released for fabrication. Specifications for the nutation wedges, mirrors, and condensing lenses of the system are being written and orders being placed to insure a delivery compatible with the fabrication requirements. Detailed design is continuing in the areas of the film magazine, phototube,

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and backlight assemblies, and crt mounts. Most of the servo components have been ordered and are expected to be received during the next reporting period.

Circuit design for modification of the breadboard correlator to incorporate the automatic sequencing functions starting with correlation gain; proceeding to x and y search and lock-on; then dynamic registration in x, y and azimuth, has been completed. The checkout and debugging phase is underway on the breadboard system and will be completed shortly. Circuitry for the match point detection and coordinate storage phase of the x and y search and lock-on function has been determined to be adequate for the final system and is being fabricated on the plug-in circuit boards.

Development of the shadow rejection system is continuing. A new tunnel diode threshold detection circuit has been developed which appears promising. The previously mentioned hysteresis effect has been reduced to an acceptable level and the noise immunity has been increased. Further checkout of this portion of the shadow rejection system has been delayed temporarily until automatic gain control circuitry is developed. It has been determined that a means of keeping the video level supplied to the shadow rejection and other circuitry constant is necessary when the scanning tube raster size is varied or when films with different contrast are inserted. Automatic gain control circuitry inserted in the video system will provide this capability. The video amplitude in each channel will be compared to a standard reference level. If a difference is detected it will be amplified and fed to the respective

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phototube voltage supply. Since the phototube gain is a function of the bias voltage applied, any variation in this voltage will effect a change in the video output of the phototube. Thus, when this feedback system is properly phased an automatic gain control can be achieved. Manual vernier video gain controls must still be provided to obtain the optimum video difference output when detecting changes, since the automatic gain controls will not provide the precision required for this function. Development of this circuitry is underway. It will be checked out on the breadboard change detector when completed.

DISCUSSION

With the completion of fabrication of the console control panel and its associated component housing, installation of the various controls and switches required to operate the console is being initiated as these components are received. Several modifications in the number and types of controls to be used have been made since the proposal was written. A listing of the function to be controlled, the type of control to be used, and other comments is shown in Table I.

[redacted]

[redacted]

TABLE I

CONSOLE PANEL CONTROLS

	Function	Control Type	Association
1.	Power Off-On	Push Switch	
2.	Azimuth Manual Control	Potentiometer	Reference Film
3.	X Manual Position	Potentiometer	
4.	Y Manual Position	Potentiometer	
5.	X Manual Position	Potentiometer	Comparison Film
6.	Y Manual Position	Potentiometer	
7.	X Cursor Control	Potentiometer	Reference Film
8.	Y Cursor Control	Potentiometer	
9.	X Cursor Control	Potentiometer	Comparison Film
10.	Y Cursor Control	Potentiometer	
11.	Scale Factor Manual Control	Potentiometer	
12.	Frame Advance-Backup	Lever Switch	Reference Film
13.	Frame Position Vernier	Potentiometer	
14.	Frame Advance-Backup	Lever Switch	Comparison Film
15.	Frame Position Vernier	Potentiometer	
16.	Frame Advance-Backup	Lever Switch	Both Films
17.	Tip Adjust	Potentiometer	
18.	Tilt Adjust	Potentiometer	
19.	View Displays	Push Switch	
20.	Automatic Register	Push Switch	
21.	Film Polarity Pos.-Neg.	Push Switch	Reference Film
22.	Film Polarity Pos.-Neg.	Push Switch	Comparison Film
23.	Video Difference (Ref. - Comp.)	Push Switch	Change Display Monitor Mode Group
24.	Video Difference (Comp. - Ref.)	Push Switch	

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TABLE I

CONSOLE PANEL CONTROLS

Continued

	Function	Control Type	Association
25.	Comparison Scene Display	Push Switch	
26.	Reference Scene Display	Push Switch	
27.	Flicker Display	Push Switch	Change Display
28.	Flicker Rate	Potentiometer	Monitor Mode
29.	Change Enhance	Push Switch	Group
30.	Background Control	Potentiometer	
31.	Area Blow-up Increase-Decrease	Lever Switch	
32.	Area Selection	Joy Stick	
33.	Video Gain Vernier	Potentiometer	Reference Film
34.	Video Gain Vernier	Potentiometer	Comparison Film
35.	Comparison Scene Display	Push Switch	
36.	Reference Scene Display	Push Switch	Reference Scene
37.	Video Difference Shadow Reject	Push Switch	Monitor Mode
38.	Shadow Reject Level	Potentiometer	Group
39.	Video Difference Cloud Reject	Push Switch	
40.	Cloud Reject Level	Potentiometer	

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All of the manual registration controls will be precision potentiometers. These will permit accurate manual registration of the two films when desired. When energized, a single automatic register switch will place the registration system in the mode for automatic correlation of the two films. From this point the registration mechanism will be sequenced automatically through the various functions, until automatic registration in x, y, azimuth and scale factor is achieved.

Each monitor will have a display mode group of push switches which will enable the operator to select the desired presentation to be displayed. The area blow-up function will be controlled by a lever switch which will provide either an increase or decrease in the amount of blow-up presented on the monitors. A joy stick will be used to position the desired area of the films to be displayed on the monitors.

FUTURE PLANS

Efforts will continue on the design phase and display data processing phase of the program.

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PROGRESS LETTER FOR PERIOD

March 1, 1963 thru April 1, 1963

NINTH MONTH OF CONTRACT

CHANGE DETECTOR

[redacted]

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5 April 1963

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The ninth month of the program has been devoted to a continuation of the design phase and display data processing phase of the program. The preliminary layout of the optical and mechanical components of the registration system has been completed. Detailed design efforts are continuing in the area of the film magazine, phototube and backlight assemblies and in the CRT area.

Design of the console cabinet is proceeding satisfactorily. A preliminary layout of the cabinet has been completed. A detailed design of the control panel and supporting shelf is underway. Fabrication of the control panel will be initiated as soon as this design is complete. Since much of the video system electronics must necessarily be located under the control panel near the controls, this electronic fabrication can be completed while the remainder of the console is under construction.

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The modification to the breadboard correlator which will enable it to be automatically sequenced thru the correlation gain, X and Y search and

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and lock-on, and X, Y, and azimuth dynamic lock-on is nearly complete. This sequencing function, although limited to the above operations will fit directly into the overall sequencing function required in the console.

The shadow rejection circuitry has been installed in the breadboard change detector and is currently being checked out. All parts of the rejection system operate satisfactorily, with the exception of the tunnel diode threshold detection circuits. These circuits are somewhat sensitive to the inherent system noise which results in false triggering of the rejection system. In addition, a hysteresis effect has been observed in which the circuit does not turn off at the same video level at which it turned on. This results in a rejection of an area larger than the shadow area. An improved circuit is being developed which will eliminate these problems.

Fabrication of electronic circuitry for the console is continuing. The plug-in version of the synchronizer is nearly ready for checkout.

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DISCUSSION

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Design efforts on the system have led to a preliminary layout of the console cabinet. An isometric view of the cabinet is shown in figure 1. While it is similar in style to the artists concept shown in the proposal [redacted] it has been laid out with a major emphasis on the functional requirements of the system. The control panel and desk assembly is designed for easy removal to permit the main cabinet to pass through a 30 inch door opening. The [redacted] "Imlock" cabinet system has been chosen as the framework for the console since it is readily adaptable to this cabinet configuration. All panels will be removable to insure complete access to any components within the console. In addition, several access doors are provided. The two film access doors and the electronics access door are shown on the upper left side of the console. On the lower right of the console are located the access doors for the power supplies and associated equipment. The console will contain its own cooling and air filtering system. One of the exhaust ports for the ventilating system is shown on the side of the taller cabinet. The monitors are tilted at a 15 degree angle with the vertical for optimum viewing and are recessed slightly to minimize glare from external room lighting. The monitors will be mounted in sliding assemblies for easy removal for maintenance.

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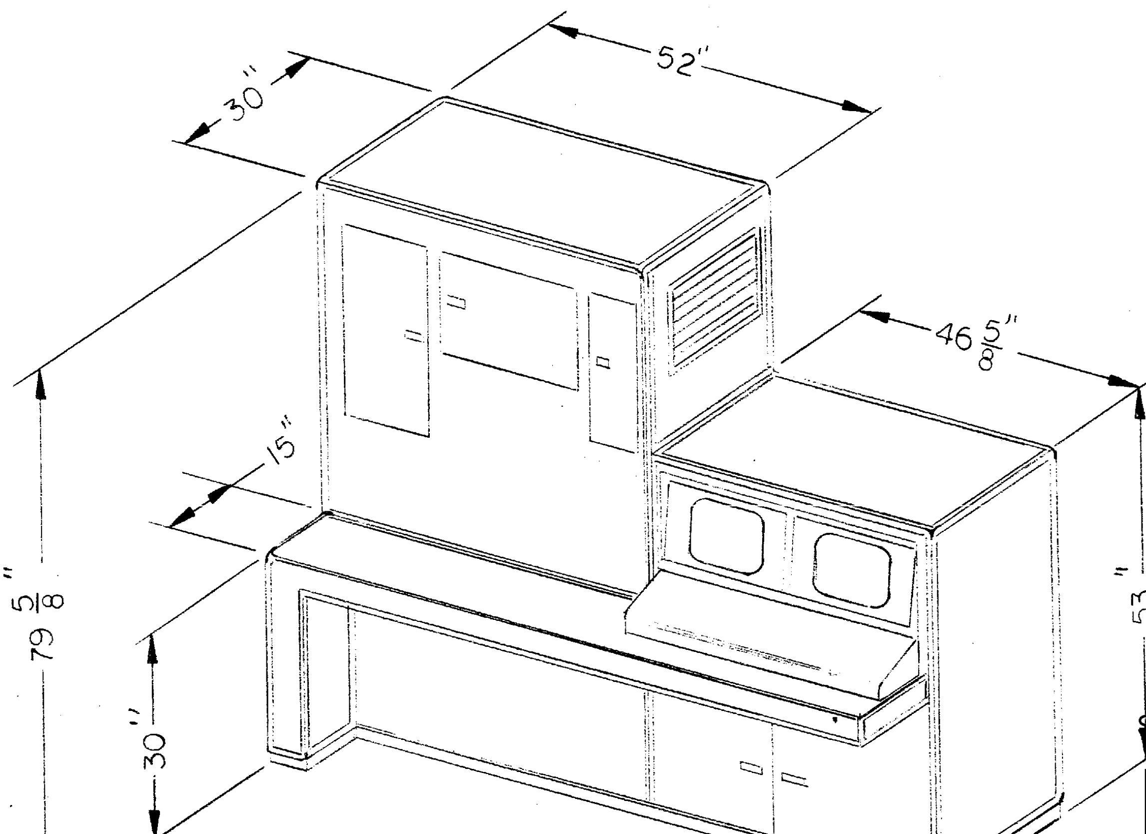

FIGURE 1 - Console

STATINTL [redacted]

Approved For Release 2002/01/02 : CIA-RDP78B04747A002600010044-5

[redacted]

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Figure 2 shows a front view of the console with the panels and doors removed. The left half of the console is exposed to show the registration system and the plug-in electronic circuitry shown in the upper right corner. In addition, other electronic circuitry, such as the CRT deflection amplifiers, and various servo amplifiers will be located in the open areas near the CRT assembly. The lower right half of the console is exposed to show the system power supplies. The power supplies are rack-mounted within the cabinet and easily removable for maintenance or service.

FUTURE PLANS

Efforts will continue in the design phase and display data processing phase of the program.

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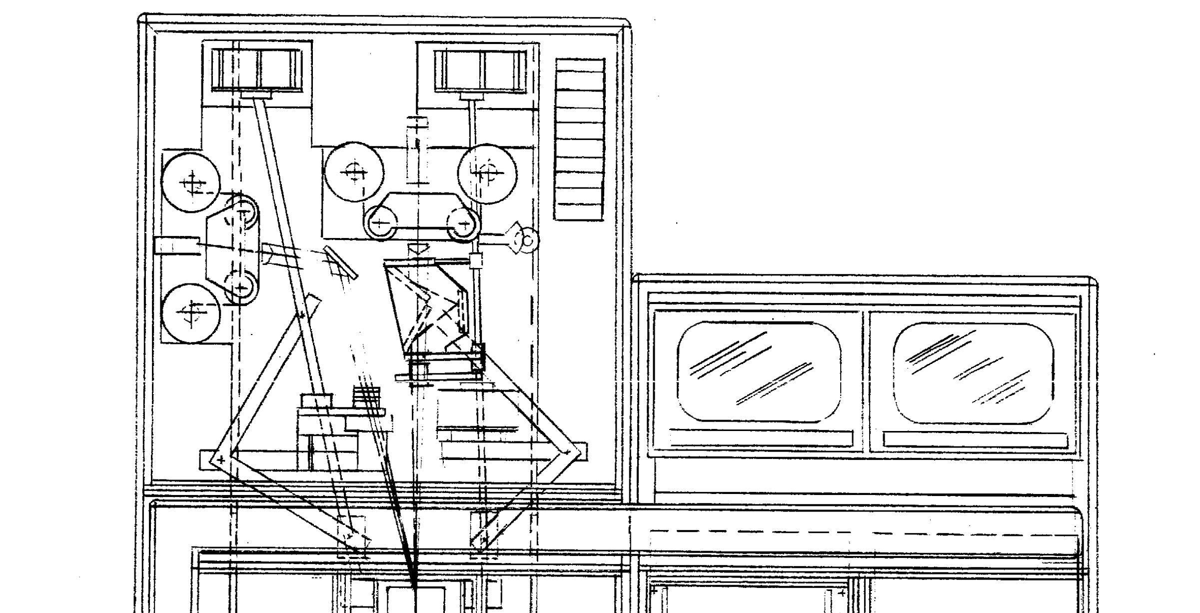

FIGURE 2 - Console with Panels Removed

[redacted]

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PROGRESS LETTER FOR PERIOD

February 1, 1963 thru March 1, 1963

EIGHTH MONTH OF CONTRACT

CHANGE DETECTOR

[redacted] 20 March 1963

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STATINTL

PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The eighth month of the program has been devoted to a continuation of the design phase and display data processing phase of the program.

The preliminary layout of the optical and mechanical components of the registration system is nearly complete. Detailed design has been concentrated in the areas of the film handling mechanism and the CRT mounting mechanism. A design of the console cabinet has been initiated which will be compatible with the registration system.

A modification to the breadboard correlator has been initiated which will enable the breadboard to be automatically sequenced through the various registration functions required in the final system. It has been determined that the various registration functions in the breadboard operate satisfactorily when tested individually, however, since for complete registration these functions must necessarily overlap, a sequential operation is required. When completed, the breadboard correlator will be programmed automatically starting with the correlation gain adjustment with the variable density wedge mechanism. It will then be switched to the X and Y search, match point

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detection and coordinate storage mode. Following this, the nutator will be turned on and X and Y dynamic lock-on will be accomplished. The half-mask will then be inserted and azimuth lock-on will be accomplished. This iterative lock-on process will be repeated three times for optimum registration. Although no automatic scale factor loop is incorporated in the breadboard, any scale error can be read out and corrected manually.

The phosphor persistance problem encountered in the .001 inch spot CRT has been completely eliminated as the tube has been aged. Development of breadboard shadow rejection circuitry has been completed. This circuitry is currently being installed in the breadboard change detector system. It is anticipated that some problems will occur when the normal system noise is introduced into the tunnel diode threshold detection circuits. Some reworking of the design may be necessary in this area.

Fabrication of the electronics to be installed in the console is continuing. Construction of the synchronizer circuitry is nearly complete. As development of other circuitry is completed it will be fabricated on plug-in boards, wherever possible, for installation in the console.

[redacted]

[redacted]

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DISCUSSION

It has been mentioned previously that the preliminary layout of the console registration system has been completed. A reproduction of this layout is shown in Figure 1. The system is shown in the readout mode with the CRT activated. Included are the manual registration rod assemblies, scale factor and azimuth variation mechanisms, nutation mechanism and wedges, and X, Y lens servos. The scale factor registration mechanism which must move the lenses axially and also move the film planes to keep the system in focus is shown with the computation arms in position. These arms mechanically compute the distances required to keep the system in focus when the scale factor is varied. The arms are tied to potentiometers which are included in the scale factor position servos of the film magazines. These position servos are necessary because the mass of the film magazines is too great for a mechanical linkage between the computor arms and the film magazines.

Most of the remainder of the registration components have been discussed in previous reports and need not be considered at this time.

It is intended that the registration system will mount vertically with the CRT at the bottom. This will permit easy access to the film magazines for film loading.

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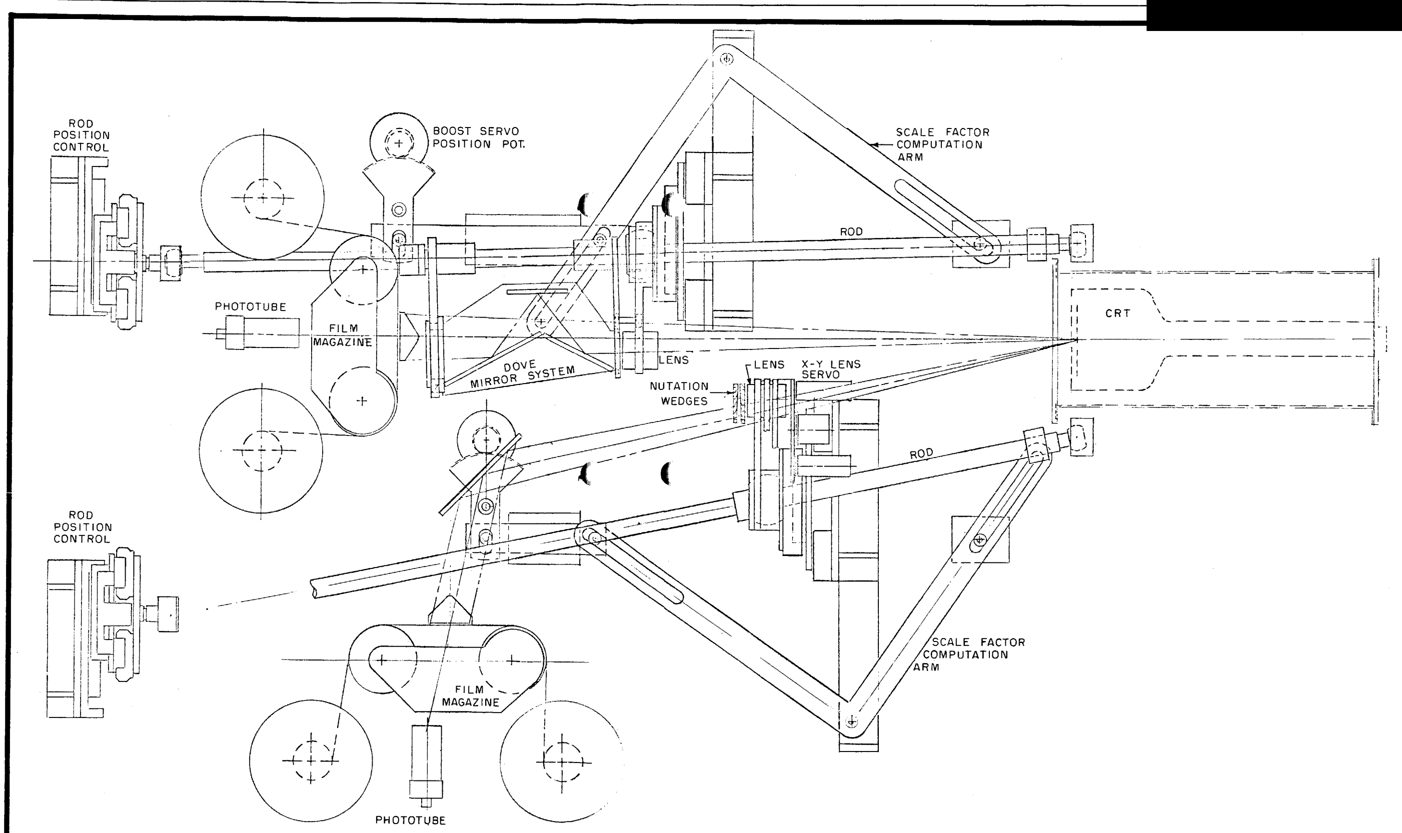

Figure 1 - Registration System

[redacted]

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FUTURE PLANS

Efforts will continue on the system design phase and the display data processing phase of the program.

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PROGRESS LETTER FOR PERIOD

January 1, 1963 to February 1, 1963

SEVENTH MONTH OF CONTRACT

CHANGE DETECTOR

[redacted]

15 February 1963

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Approved For Release 2002/01/02 : CIA-RDP78B04747A002600010044-5

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STATINTL

PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The seventh month of the program has been devoted to a continuation of the design phase and display data processing phase of the program.

A preliminary layout of the optical and mechanical components of the registration system to be used in the console has been nearly completed. Upon completion of this preliminary layout, detailed drawings of the individual mechanisms of the registration system will be generated and released to the engineering shop for construction.

Fabrication of the breadboard variable density wedge mechanism, required for registration of scenes with differing contrast and base density, has been completed. The mechanism has been installed in the breadboard correlator and is currently being checked out.

Match point detection and coordinate storage circuitry, necessary to locate the match point during the search mode, has been installed in the breadboard correlator. A modification to the breadboard lens drive mechanism was

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incorporated in order to reduce the search amplitude to approximately the same as that which will be used in the console. Preliminary tests on these units have determined that the match point detection and coordinate storage circuitry can locate the true match point of two aerial photographs and position the lens servo at that match point. Further testing is being performed to determine the accuracy and sensitivity of the circuitry.

The .001 inch spot diameter tube has been installed in the breadboard change detector. A readout resolution of 28 line pairs per millimeter has

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been obtained using the USAF test target. The cataphoretically coated [redacted] phosphor grain size is considerably smaller than that of the [redacted] previously used in the system. A phosphor persistance problem was observed when the tube was initially installed, however from information supplied by the manufacturer, it was determined that an initial "burn in" or aging of these high resolution tubes is required. As of this writing with approximately 40 hours on the tube, the phosphor persistance has dropped to a value which is acceptable for use in the system.

The raster positioning yoke and circuitry have been installed in the breadboard. This offers the capability of scanning any desired portion of the scenes. Tests will be conducted on this raster positioning function to determine if any astigmatic condition in the CRT spot is encountered as the raster is displaced from the center of the tube.

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Construction of the electronic circuitry for the console has been initiated

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during this period. Plug-in circuit boards are being used wherever possible due to their ease of installation and accessibility for service and maintenance. The synchronizer has been chosen as the first of the circuitry to be constructed in this manner, since its development has been essentially completed. As other circuitry is developed and breadboarded it will be built upon circuit boards for use in the final system.

The report covering the results of a study conducted to determine the components and efforts necessary to increase the readout resolution of the system was completed during this reporting period.

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DISCUSSION

Among the efforts being conducted on the display data processing studies phase of the program are methods of removing from the change display any changes caused by shadow differences which occur when the two photographs are taken at different times of the day. Shadows cast from objects exhibit several attributes when presented on film which permits them to be separated from the remaining material in the photograph. The first attribute of a shadow (assuming a positive transparency) is that it is, in general, the most dense area of the photograph. In intense sunlight when the shadow is most apparant the density attribute becomes most valid. In hazy sunlight the shadow density becomes more difficult to separate from its surroundings, however, it also becomes less objectionable on the change display. The second attribute of a shadow on a photograph is that within the shadow there is considerably less variation of the density than in the surrounding areas. This is due mainly to a lack of sensitivity of the film in the dark areas. This loss of spatial frequencies within the shadow is a useful characteristic which can be used for rejection. The third attribute of shadows which may be useful for rejection is that the orientation of all the shadows in a particular photograph will always be the same.

Circuitry is currently under development which will reject shadow differences on an amplitude or density basis. A block diagram of the video system from the phototubes to the monitors including the shadow rejection circuitry is shown in Figure 1. Beginning at each phototube the respective video signals

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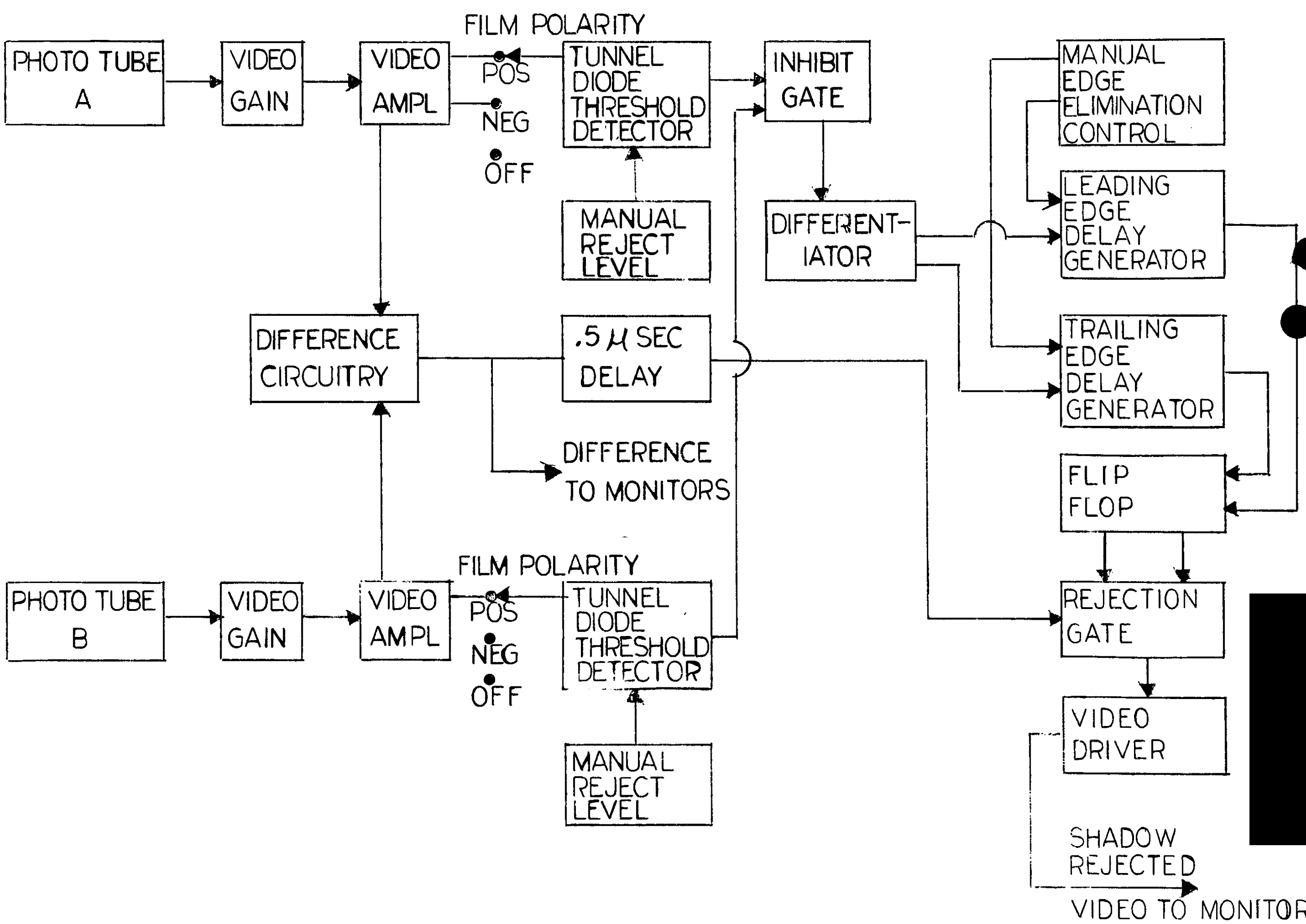

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FIG 1 VIDEO SYSTEM

Approved For Release 2002/01/02 : CIA-RDP78B04747A002600010044-5

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are amplified with gains adjusted to the desired values. The difference circucitry inverts the desired signal to obtain the difference (A-B) or (B-A). When no shadow rejection is necessary, this difference is then fed directly to the change display monitor. When shadow differences are apparent the rejection circuitry is made operable by selecting the proper mode of the switch, either positive or negative depending on the polarities of the films. Rejection of the shadows is accomplished by sensing the amplitude of the shadow and returning this amplitude to the neutral grey level of the change display background. The threshold level at which the shadows will be rejected has been made operator variable so that the possibility of rejecting dense areas which are not shadows will be minimized.

A problem which occurs when shadow rejection is based on amplitude information is that, due to the finite system bandwidth and film resolution limitations, instant transition from non-shadow area to shadow area in the video waveform is not possible. Thus the shadow area will have reached the rejection threshold level before the rejection circuitry can return the amplitude to the neutral background level. This results in an edge outlining of the shadow area with a width proportional to the rise and fall times of the video waveform of the shadow area. Circuitry to eliminate this problem is shown in Figure 1. A fixed delay of 0.5 microsecond is added to the video difference output while no delay is added to the tunnel diode threshold detectors which operate on the individual video waveforms. The waveforms from the tunnel

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diode circuits which represent the shadows to be rejected are combined in the inhibit gate so that only differences in shadows will be rejected. The resultant waveform is differentiated and the leading edge is used to trigger a 0 to .5 microsecond delay multivibrator, while the trailing edge is used to trigger a .5 to 1 microsecond delay multivibrator. The outputs of the delay multivibrators trigger a flip-flop which drives the rejection gate. Assuming a video waveform with a shadow area having a rise and fall time of .5 microsecond, the tunnel diode threshold circuit will trigger .5 microsecond after the shadow has actually started. However, the fixed delay of .5 microsecond in the video difference line will place the start of the rejection circuitry exactly in coincidence with the start of the shadow if the leading edge delay multivibrator is set for 0 delay. The trailing edge delay multivibrator must be set for 1 microsecond to insure coincidence of the rejection circuitry with the end of the shadow. For scenes having shadows approaching instantaneous rise and fall times the leading and trailing edge delay multivibrators must each approach .5 microsecond delay. The cirucitry being developed contains a single control which will set each delay multivibrator to the proper position by observing the monitor and adjusting for minimum edge outline of the rejected shadows.

It may become necessary to combine either or both of the other shadow attributes with the one currently being explored, however it is felt that more data on the effectiveness of this method is needed before any combination is attempted.

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FUTURE PLANS

Efforts will continue on the system design phase and display data processing studies phase of the program.

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PROGRESS LETTER FOR PERIOD

December 1, 1962 to January 1, 1963

CHANGE DETECTOR

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10 January 1962

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographical area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The sixth month of the program has been devoted to a continuation of the design phase and display data processing studies phase of the program.

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A breadboard version of the dove mirror system for azimuth rotation has been installed in the breadboard change detector. The dove mirrors have been evaluated in conjunction with the 9 1/2" [redacted] lenses in the breadboard and the combination has been determined to be satisfactory with respect to distortion and resolution. As a result, design efforts for the final system are continuing utilizing the [redacted] lenses and the dove mirror system.

STATINTL

Considerable effort has been expended during this period on the determination of components and efforts required to increase the readout resolution of the system. Items which must be considered include: a smaller spot diameter CRT, regulated high voltage power supply, regulated focus supply, dynamic focus requirements, optical focusing capability of the system, and registration accuracy of the system. In addition, methods of suppressing the raster lines in the monitors are also under investigation. The report discussing the recommended approaches and goals will be available in mid-January.

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The .001 in. spot diameter CRT which will meet the existing system design goals has been received from [redacted] It is a slightly modified version of the [redacted] Approximately 1 inch has been added to the neck length of the tube in order to move the deflection yoke reference line back to allow for insertion of the separate raster position yoke in front of the deflection yoke. This modification was necessary to eliminate excessive defocusing of the spot and neck shadow that would have occurred with the use of the position yoke. This tube is currently being mounted in the breadboard system for checkout.

The special raster positioning yoke has also been received and is being installed on the new CRT for evaluation.

The match point detection and coordinate storage circuitry is being installed in the breadboard correlator. The correlator has been modified in order to generate the lateral and longitudinal search functions to be used in conjunction with the match point circuitry. When the installation is complete, the breadboard correlator will be able to automatically search and find the match point of two scenes in x and y, dynamically lock-on in x and y, and dynamically lock-on in azimuth.

Fabrication of the breadboard version of the variable density wedge mechanism necessary to keep the registration gain nearly constant has almost been completed. When installed in the breadboard correlator, photographs with varying levels of base density and contrast will be registered to determine if the operation is satisfactory. Design of circuitry for shadow rejection is proceeding according to schedule.

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DISCUSSION

Design efforts in the circuitry and components associated with generating, focusing and positioning of the raster on the scanning CRT have resulted in some modification and improvements to the scanning portion of the system. The basic requirement of the CRT system is to present a 525 line raster which scans each of the film frames in synchronism. Initially, with the optics of the system set at unity magnification, the raster size must be 70 mm along its minimum or vertical dimension to get full coverage of the 70 mm film frame. When it is desired to examine in detail a particular area of the films, the raster size is then reduced and positioned accordingly to view the desired area. In order to fully utilize the increased readout resolution when the system is operated at the reduced raster size, a correction voltage (dynamic focus) must be applied to the focus anode of the CRT to keep its spot in optimum focus.

The size of the raster will be varied by changing the amplitude of the sweep waveforms into the vertical and horizontal deflection amplifiers. This will be accomplished by means of two ganged potentiometers inserted between raster waveform generation circuitry and the deflection amplifiers. This function can be performed either manually or automatically by the raster size control mechanism as a function of the overlap of the two film frames.

Positioning of the raster is accomplished by two methods. Positioning in the vertical direction is performed by feeding a d-c voltage derived from the manually controlled vertical position potentiometer into the vertical

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deflection amplifier and deflection yoke. Horizontal positioning, however, cannot be accomplished by this method since the horizontal deflection amplifier cannot effectively handle the large direct current excursions required for raster positioning along with the 15,750 cycle deflection waveform. As a result, a special horizontal raster positioning yoke has been developed which will be inserted in front of the regular deflection yoke. The horizontal raster position voltage is derived from the manually controlled horizontal position potentiometer. It is then amplified and fed directly to the special position yoke. In order to accommodate the extra yoke without excessive defocusing of the spot, approximately 1 inch was added to the neck length of the [redacted] CRT by the manufacturer.

It has been determined that only the raster position information is needed to dynamically focus the CRT in order to meet the existing resolution specification. Originally, it was felt that both position and raster size information was required. If the resolution specification is increased both may again be needed, but for the present only position is being considered. The dynamic focus requirements discussed in the August Progress Letter must still be met, however, the distance D in the equation $V = 39D^2$ can be measured to the center of the raster regardless of its size with neglible defocusing at the corners. A functional block diagram of the simplified dynamic focus system is shown in Figure 1. Breadboards of the circuits and components are nearly complete.

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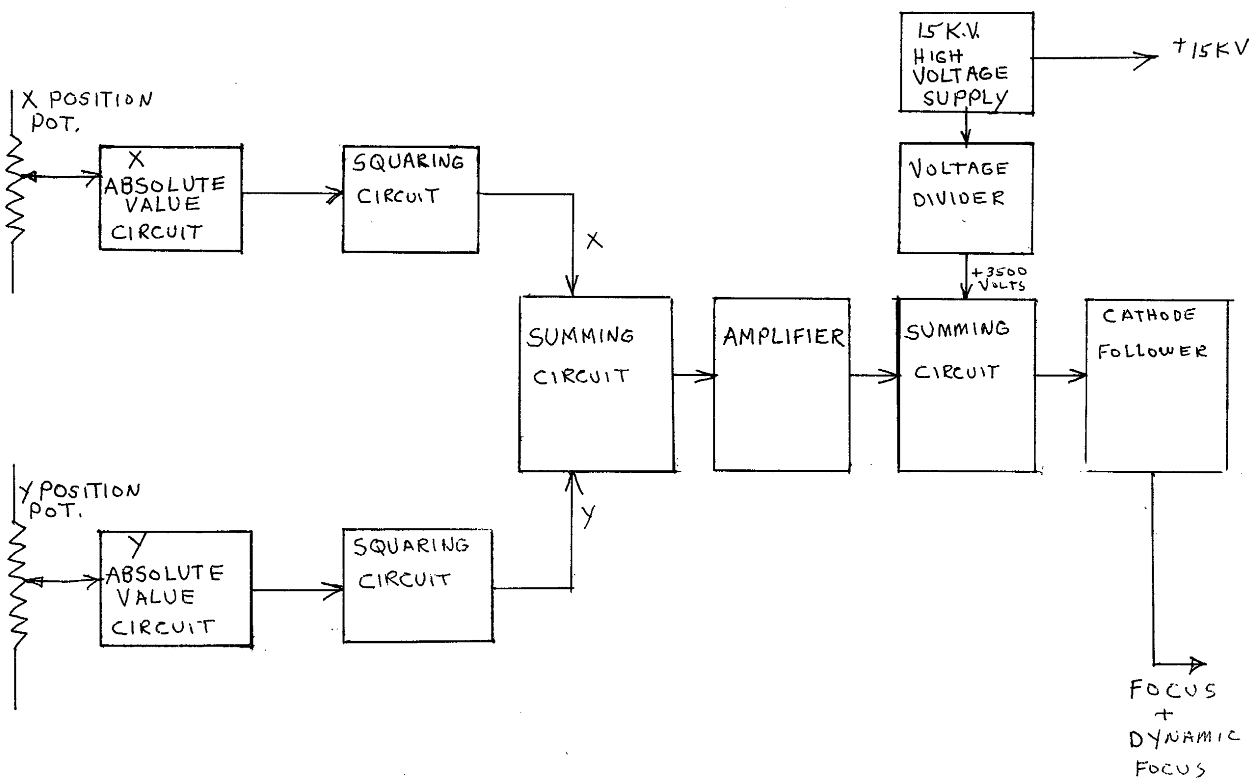

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FIG 1 FOCUS AND DYNAMIC FOCUS SYSTEM

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PROGRESS LETTER FOR PERIOD

November 1, 1962 to December 1, 1962

CHANGE DETECTOR

[redacted]

20 December 1962

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Program Objectives

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

Factual Data and Observations

The fifth month of the program has been devoted to a continuation of the design phase and display data processing studies of the program.

A modification of the optical design of the system has been initiated in order to utilize the dove mirror system for azimuth variations. The physical size of the dove mirror system requires a longer optical path in order to be inserted properly. Two [redacted] 9-1/2 in. f 6.8 enlarging lenses have been received and are being evaluated for use in this longer optical system.

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Discussions with customer representatives have determined that a requirement exists to increase the readout resolution of the system above the design goal of 40 TV lines/$_{mm}$ (20 optical line pairs/$_{mm}$). A study is underway to determine the maximum resolution obtainable from state-of-the art components as well as the requirements on other parts of the system to fully utilize higher resolution. A separate report will be written which discusses the ramifications of increasing the system resolution.

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[redacted]

Fabrication of a breadboard version of the variable density wedge mechanism to compensate for variations in film base densities and contrasts during the registration mode has been initiated. When completed it will be installed in the breadboard correlator for evaluation.

Tests on the [redacted] lenses have shown them to be inadequate for 5 in. and larger formats. Tests on the aforementioned [redacted] lenses will be conducted to determine their multi-format capabilities.

Development of matchpoint detection and coordinate storage circuitry is continuing. Upon completion of development of this circuitry it will be installed in the breadboard correlator for checkout.

Development of circuitry for meeting the dynamic focus requirements of the CRT has been initiated. This circuitry will generate the necessary voltage to keep the raster in focus on the CRT regardless of the raster size or position.

Work on the shadow rejection circuitry is continuing. As this circuitry is completed it will be incorporated into the breadboard change detector for testing.

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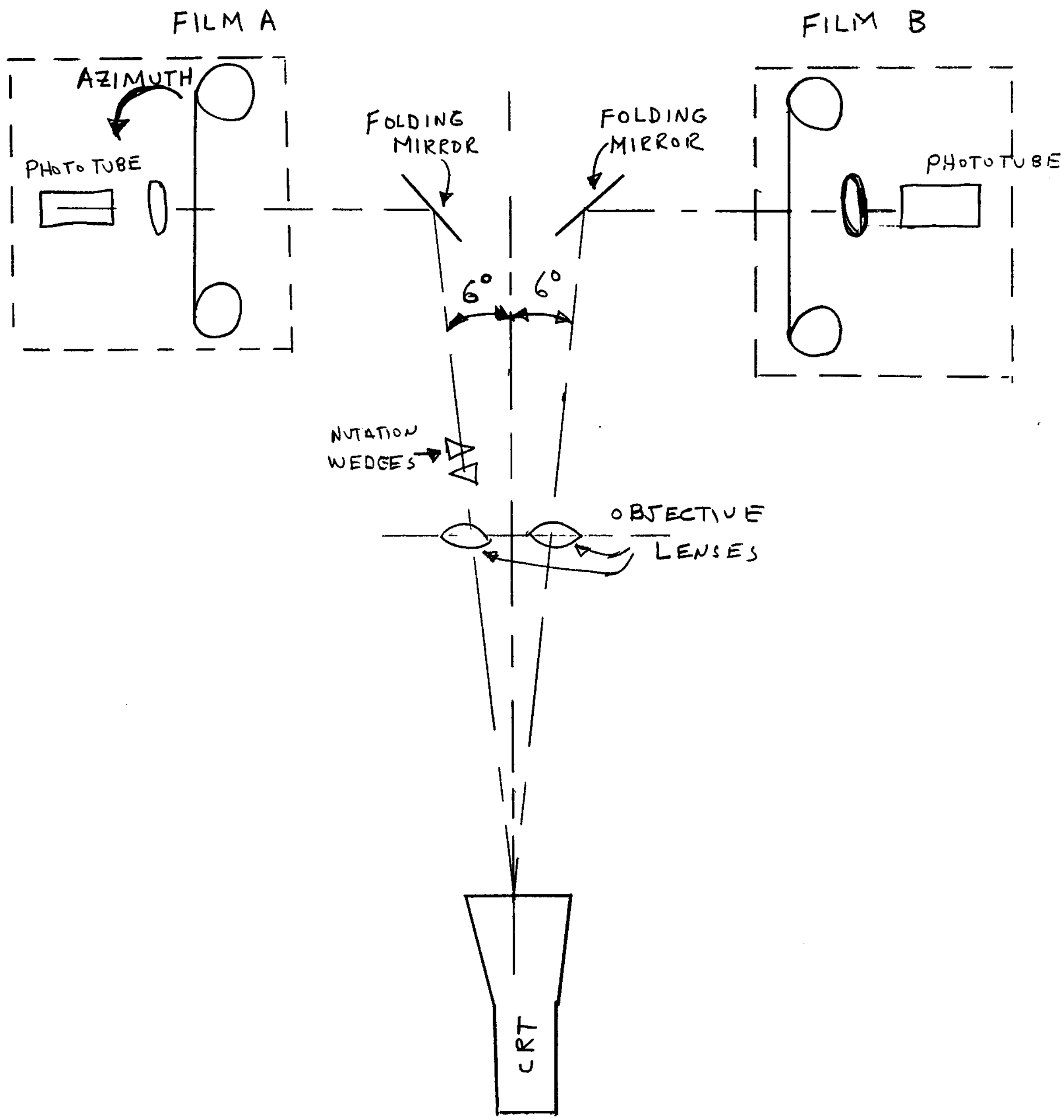

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FIG 1. ORIGINAL OPTICAL SYSTEM

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Discussion

It has become increasingly obvious during the early months of the program that azimuth corrections made by physical rotation of the films was undesirable for several reasons. Rotation of the bulky film handling mechanism would require a large and powerful servo. The film indexing function would become a serious problem. In addition, this method of azimuth variation would further complicate the multi-format problem. As a result considerable design effort has been placed on other methods of azimuth variation.

A dove mirror system has been developed which will perform azimuth correction, however some changes in the overall optical system are necessary in order to use it. Consider the original optical system concept as shown in Figure 1. Azimuth rotation was done at the film planes. Each side of the split optical system was set along the rods at a nominal angle of 6 degrees from a centerline perpendicular to the face of the CRT to assure clearance of all the mechanisms in the optical paths. Insertion of the dove mirror system into this optical setup is not feasible for several reasons. The length of the assembly required to hold the dove mirror system is greater than the space available in the optical path with the existing 7-1/2 inch focal length lens. Also, rotation of the dove mirror system about the 6 degrees offset results in a focal shift and tilt in the image as the azimuth is varied.

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A modification of the original optical concept which will eliminate these problems is shown in Figure 2. The side of the system which incorporates the dove mirror system is placed on the centerline. The other side must be placed at a nominal 12 degrees from the centerline to assure the same clearance of the mechanisms as in the original system.

This new optical system was set up on the breadboard change detector and it was determined that the 12 degree off-axis requirement on one lens was beyond the capability of the [redacted] 7-1/2 in. focal length lens. Severe shading and loss of resolution was observed in that channel. 9-1/2 in. focal length [redacted] lenses were ordered and placed into the breadboard when received. Negligible shading and no discernable loss of resolution was observed when these lenses were installed in the breadboard. The use of these longer focal length lenses also allows more room for placement of the dove mirror system in the optical path.

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A reversion of the image occurs when the dove mirror system is placed in the optical path. In order to keep the images in each channel of the optical system in the proper geometric relationship the folding mirror which also reverts the image has been removed from the optical channel which contains the dove system.

<u>Future Plans</u>

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Efforts will continue in the system design and display data processing studies phases of the program.

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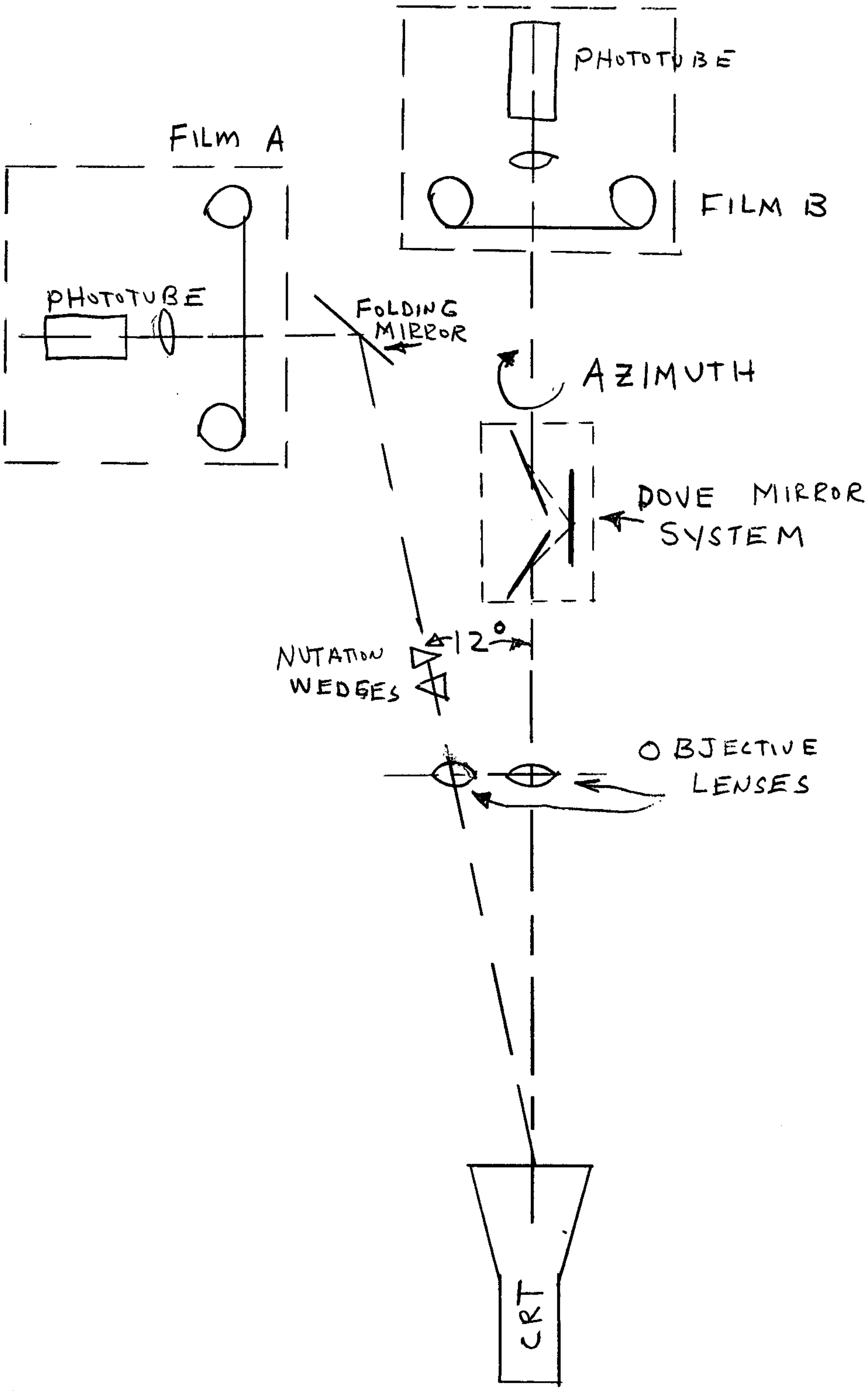

FIG 2 MODIFIED OPTICAL SYSTEM

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PROGRESS LETTER

FOR

PERIOD OCTOBER 1, 1962 TO NOVEMBER 1, 1962

CHANGE DETECTOR

[redacted]

20 November 1962

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PROGRAM OBJECTIVES

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imagery was obtained.

FACTUAL DATA AND OBSERVATIONS

The fourth month of the program has been devoted to the initiation of the design phase and the display data processing studies phase of the program.

An improved method of correlating the two scenes in all four axes in the automatic registration mode is under development. This method utilizes a full correlation mask and half-mask combination that with only lateral and longitudinal nutation applied results in registration in x, y, scale factor and azimuth. A breadboard correlator has been constructed which automatically registers two scenes in x, y, and azimuth utilizing this method.

Methods of varying the azimuth of the two scenes other than physical rotation of the films are under investigation. One method which appears promising is the insertion of a dove mirror system similar in operation to the dove prism, along one of the optical paths. Rotation of the dove mirror system results in rotation of one of the images of the scenes. Considerable design effort

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is being expended in this area since it is felt that a method of azimuth variation without physical rotation of films will enhance the mutiformat considerations of the system.

In connection with the mutiformat considerations of the system, a preliminary investigation of the suitability of the pro-raptar lenses chosen for the 70 mm system for 5 in. and larger apertures has shown them to be marginal. This lens is not designed for large aperture coverage and noticeable degradation of resolution was observed as the coverage was increased above 70 mm. Other longer focal length lenses capable of larger coverage have been ordered and will be evaluated as soon as received.

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The [redacted] phototube has been selected for the system. Comparison tests were conducted between the [redacted] a much larger tube. The signal-to-noise and linearity measurements of each of the tube types showed them to be nearly identical. The [redacted] was chosen, therefore, because of its smaller size.

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Design of a breadboard mechanism which will hold the maximum amount of light reaching the phototube during the automatic registration mode relatively constant regardless of the base densities and contrast of the two films has been initiated. The basic approach is to use the phototube to sense the light and feed back the voltage out of the phototube to servo controlled variable density wedges placed in front of the backlite. If the product of the base densities of the films increases the servo will position the

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variable density wedge to allow more light to be generated by the backlite. Conversly, if the product of base densities decrease the servo will position the wedge to allow less light to be generated.

Development of matchpoint detection circuitry and circuitry for storing the x and y coordinates of the match point has begun. The matchpoint detector will sample the phototube signal as the image of one scene is searched across the other and select the maximum second derivative of the signal as the true matchpoint. This type of matchpoint detection was chosen since it is more reliable than a threshold type.

Work has been started on the development of shadow rejection circuitry. The first approach will be to use the density of the shadow as the criterion for rejection.

The resolution capability of the existing breadboard system has been measured using a standard USAF resolving power test target. The resolution limiting element of the system was determined to be the .0015 in spot [redacted] cathode ray tube. The optical resolution capabilities of system with unity optical magnification were 22 line pairs per millimeter at maximum electronic blow-up and 7 line pairs per millimeter with complete coverage of a 70 millimeter scene. Considerable improvement is expected when the .001 in CRT is installed in the system.

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DISCUSSION

Last month's report discussed the rod approach under development for manual initial alignment of the two scenes. This discussion will present the design approach under development for automatic registration of the two scenes.

Consider the simplified schematic of the system shown in Figure 1 as it exists in the automatic registration mode. It is assumed that the search function has placed the image of one scene on the other within the dynamic lock-on range of the system. Azimuth variations are shown as a physical rotation of the scenes for simplicity, however rotation of the images can be accomplished by the dove mirror system previously mentioned.

Assume that the image of one scene on the other for the simple targets shown in Figure 2. Small translational, azimuth, and scale factor errors exist in the registration. If the x and y servo loops are now closed through the phase detectors and lens servo with the nutation wedges generating the conventional circular nutation, x and y error signals will be generated to null their respective servos. The two scenes will register to the centroid of the target area. The x and y lens servos are locked into this position. A half-mask is then inserted over the image of one of the scenes to blank out half of the image as shown in Figure 3. If a rotational error exists in the area now being correlated it will show up in the y channel phase detector since the x components of the error signal

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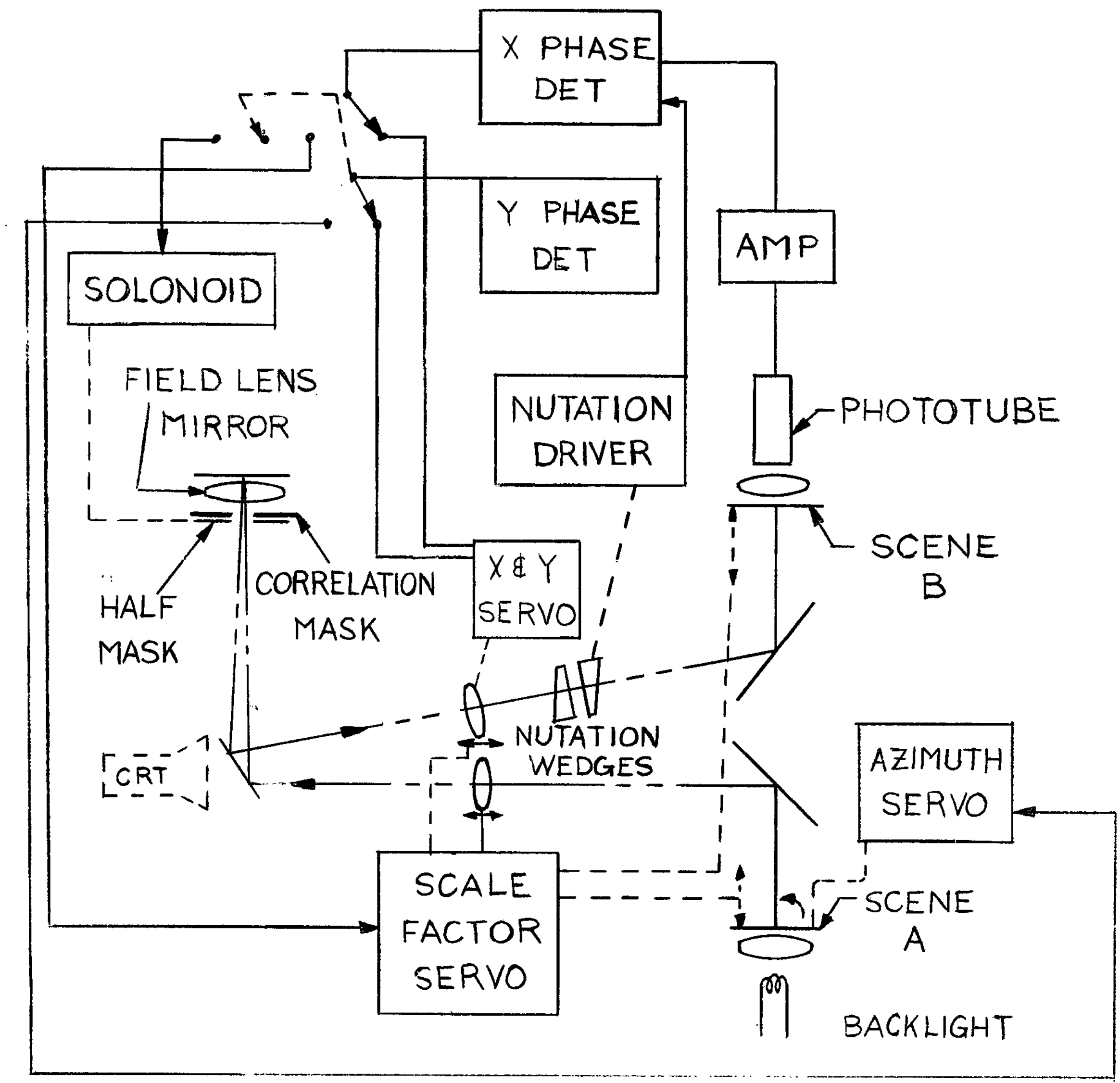

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FIGURE 1
CORRELATION SYSTEM

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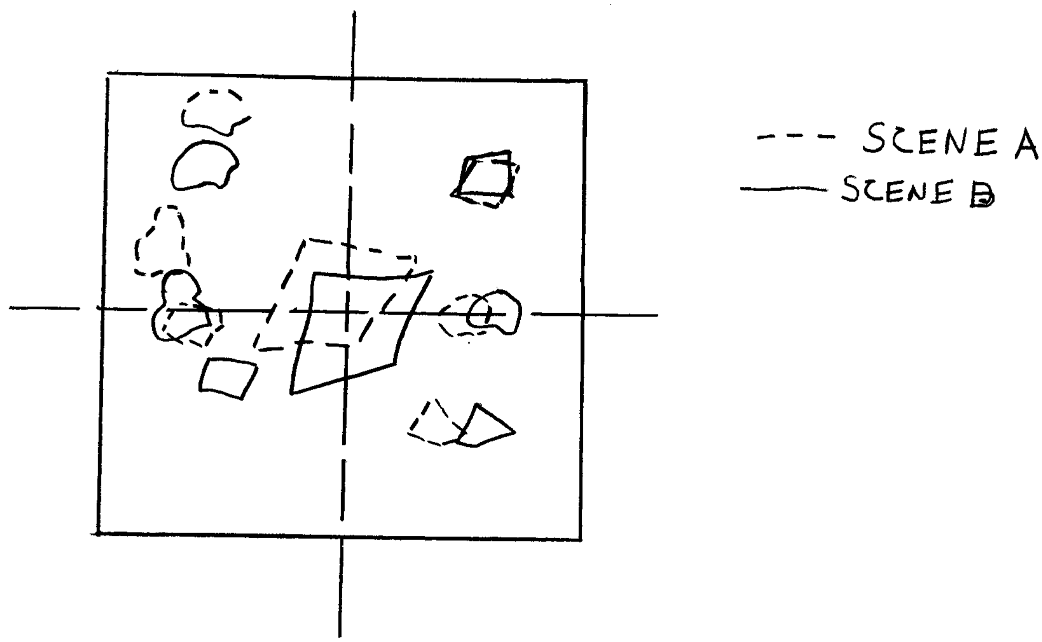

FIG 2 — SUPERIMPOSED IMAGES WITH X, Y, SCALE FACTOR AND AZIMUTH ERRORS

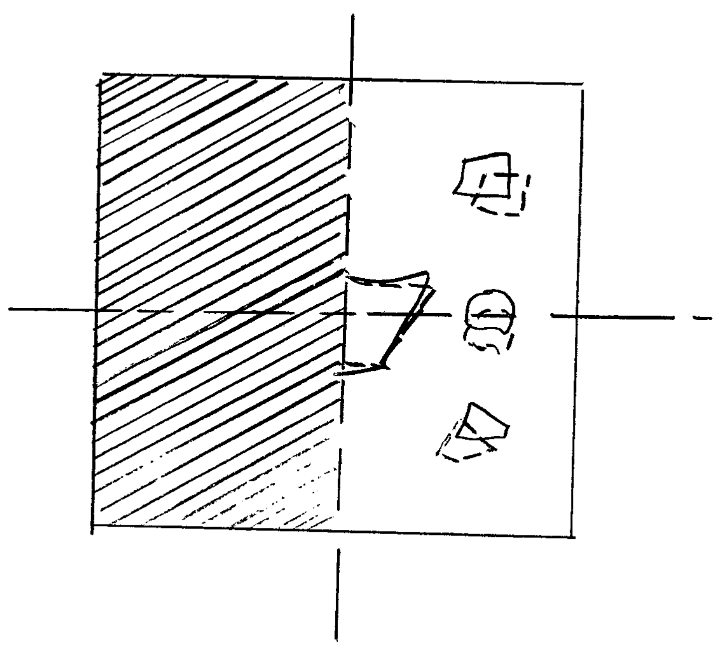

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FIG. 3 — SUPERIMPOSED IMAGES WITH HALF-MASK INSERTED AFTER X & Y CORRELATION

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generated by circular nutation of the targets above and below the center line of the images cancel. Similarly, a scale factor error between the two scenes shows up as an x error in the phase detectors since targets above and below the center line of the correlation area generate equal and opposite error signals which cancel in the y channel.

The y error signal can be fed directly to the azimuth servo to null the rotational error, and the x error signal can be fed to the scale factor servo to null the scale factor error. With the nulling of the azimuth and scale factor accomplished, a smaller x and y error will be introduced.

The azimuth and scale factor servos must then be locked in position, the half-mask removed and the x and y phase detector converted to their respective lens servos. When registered in x and y the same process must again be repeated for scale factor and azimuth. It is anticipated that a maximum of three complete operations will be required to obtain the desired accuracy of registration.

The advantage of this method is that only one nutation mechanism is required to register the two scenes in x, y, scale factor and azimuth. The time required to complete 3 operations is still less than that required to perform simultaneous nutation in all four axes since to nutate a large mass especially for scale factor would require a very low nutation frequency.

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The requirement that the center of rotation and center of scale factor

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variation be on the center of the two scenes to be correlated is compatible with the optical approach discussed in the previous report. The centroid of the overlap area of the two films to be registered is always kept at the center of rotation and center of scale factor variation by the rods.

A breadboard system utilizing this method has been constructed which registers two scenes in x, y, and azimuth. Correlation of typical aerial photographs in these three axes has been achieved. In addition, the scale factor of the two photographs has been varied and satisfactory scale factor error signals have been observed. A breadboard scale factor servo has not been fabricated due to the complexity of the mechanism.

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Progress Letter for Period

September 1, 1962 to October 1, 1962 TH[illegible] MONTH OF CONTRACT

CHANGE DETECTOR

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Program Objectives

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occurred between the times that the imaging was obtained.

Factual Data and Observations

The third month of the program has been devoted to the completion of the system predesign phase of the program.

Efforts on the system design task have resulted in several modifications to the initial design concept. In order to eliminate some of the large number of position servos required for both manual positioning and automatic registration of the two scenes, a method of attaching the lenses and other registration elements to rods which duplicate the optical path requirements for registration has been devised.

Discussion with customer representatives during this month has resulted in the decision that the multi-format studies should continue for several more months. It was also decided that the design of this model should be limited to 70 mm formats since an attempt to incorporate larger formats would cause considerable delay in the development and fabrication of the system. The 8-inch condensing lenses have been received and the study to determine the compatibility of the Pro-rapter objective lenses with a 5-inch format has been initiated. In connection with the optical system requirements, two

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phototube types have been chosen which meet the noise, shading, and linearity requirements of the system. The tubes chosen [redacted] are undergoing further tests to determine which is the most acceptable.

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Work on the breadboard system has resulted in the completion of breadboard circuitry necessary to show all changes in the same polarity (white). This circuitry also permits the background or unchanged area to be blanked out to any desired degree. A breadboard synchronizer has been developed. It is capable of supplying the necessary sync and blanking waveforms to the CRT and monitors in order to produce a fully interlaced 525 line raster.

Design specifications have been completed in the following areas: CRT and associated power supply requirements, dynamic focus, deflection amplifiers, deflection yoke, synchronizer, raster generator, match-point detector and coordinate storage, phase detectors, and system low voltage power supplies. Generation of specifications of the other areas is continuing.

STATINTL

[redacted] 14-inch professional monitors have been ordered for use initially in the display data processing studies and ultimately in the system console. These monitors are of studio quality. They have regulated power supplies and employ circuitry capable of supplying a higher resolution more stable presentation of video signals than the monitors currently in use in the breadboard system.

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Discussion

It has been increasingly apparent during the study phase that to use position servos to obtain manual adjustment in X, Y, scale factor, and azimuth; to perform automatic registration in these four axes; and to perform the correlation mask and raster size adjustment functions would result in prohibitively large number of these servos. As a result another approach which will eliminate many of the servos formerly required is under development.

In order to best explain this new approach, the basic optical paths of the system should first be examined. This can be represented in simplified form as a screen, S; the two objective lenses, l_1 and l_2; and the two scenes, T_1 and T_2, as shown in Figure 1A. Registration of corresponding areas of T_1 and T_2 will automatically result in registration of their respective images on the screen, S, due to the system geometry. The screen represents the CRT face in the initial alignment and readout modes of the system and the field lens-mirror combination in the automatic registration mode.

Consider the situation shown in Figure 1B which could exist in the acquisition of the input data that would result in a requirement for the system to align the resulting transparencies in all axes. The difference in the principle point locations would require translational corrections, the difference in orientation would require azimuth corrections, and the difference in coverage of the photographic frames would necessitate a scale factor correction.

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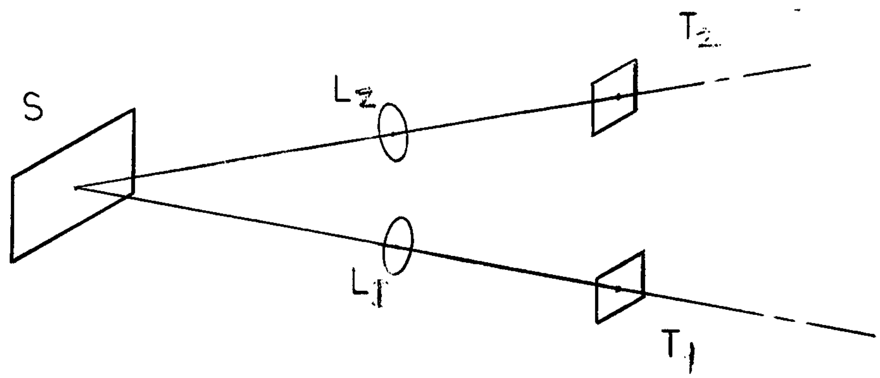

FIG. 1A
SIMPLIFIED GEOMETRY OF SYSTEM

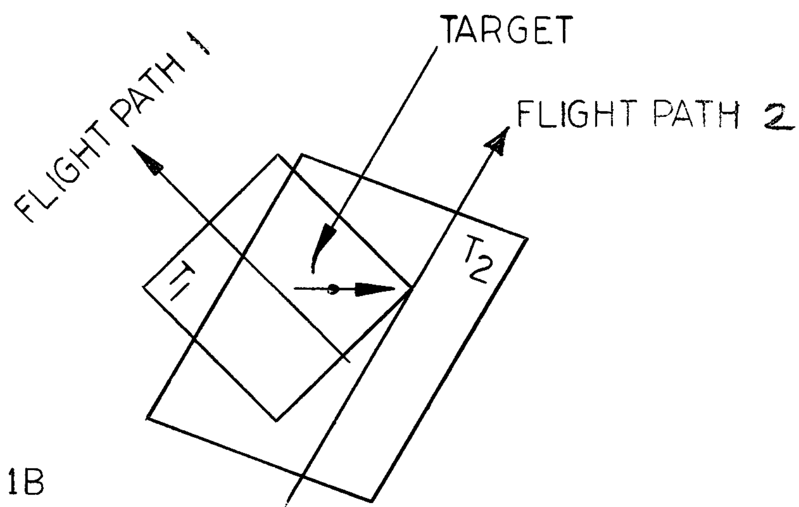

FIG. 1B
DATA AQUISITION

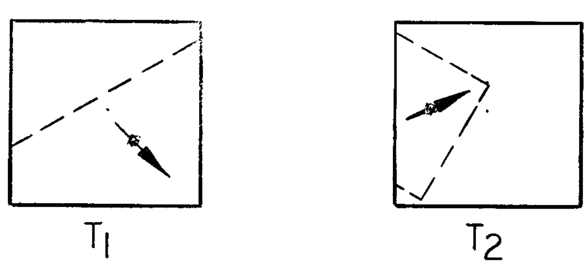

FIG. 1C
TRANSPARENCIES

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Figure 1C illustrates the transparencies as they would be inserted in the system with the position of a sample target (arrow) located at the centroid of the overlap area. The overlapping area is also shown dotted in. Figure 2A shows the transparencies inserted in the simplified system with the resultant image of the target shown at the screen plane. To register the scenes in the translational axes the centroid of the overlapping area of each transparency must be imaged at the center of the screen surface. This requires a translation of the optical axes in the X and Y directions as shown in Figure 2B. The optical path intersecting at scene T_1 must be translated the distance (X_1', Y_1') and that scene T_2 must be translated the distance (X_1', X_2'). With the centroid of the overlap area properly positioned, azimuth registration is the next process. This is illustrated in Figure 3A. Rotation of the transparencies is one approach being considered. From the previous figure the center of the optical axis intersects T_1 at the point $P'(X_1', X_1')$. A rotation through the angle θ_1 is introduced to the transparency T_1. The complete optical path including the lens l_1 is forced to rotate through the same angle. This is done to prevent translation of the image at screen, S, due to the fact that the centroid of the overlap area at the scene T_1 is not the center of rotation of T_1. Rotation of the optical path along with the transparency transforms the centroid of the overlap area to the center of rotation. The new position of the optical center line is now at the point $P''(X_1'', Y_1'')$. The transparency T_2 is rotated through the angle θ_2 and the resultant intersection of the optical path and T_2 is $P''(X_2'', X_2'')$. The resultant image at S is now initially registered in X,Y and azimuth. Other

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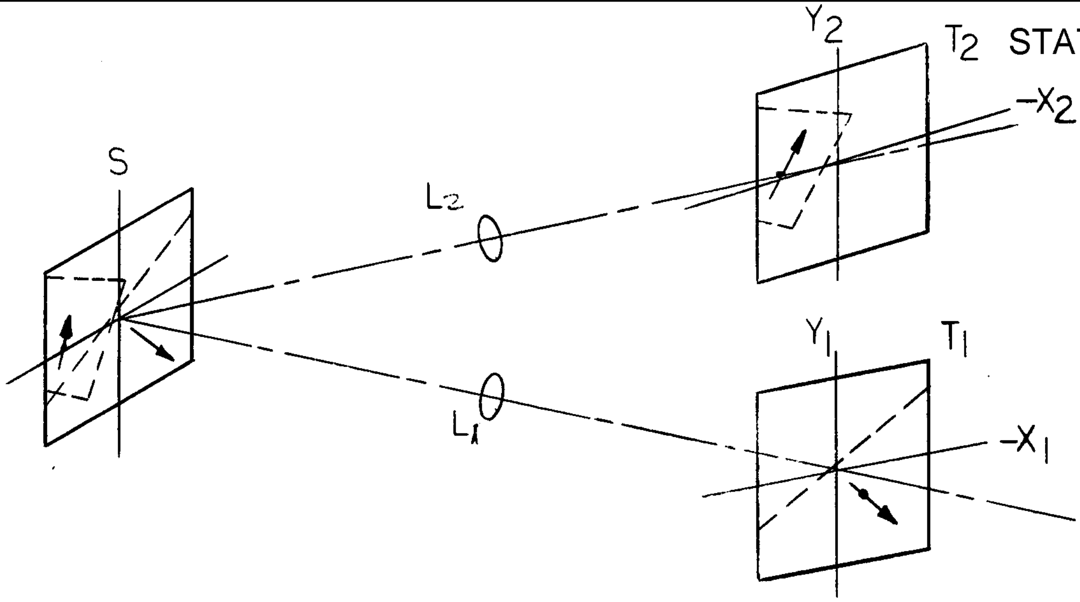

FIG. 2A

SYSTEM AFTER INITIAL INSETION OF SCENES

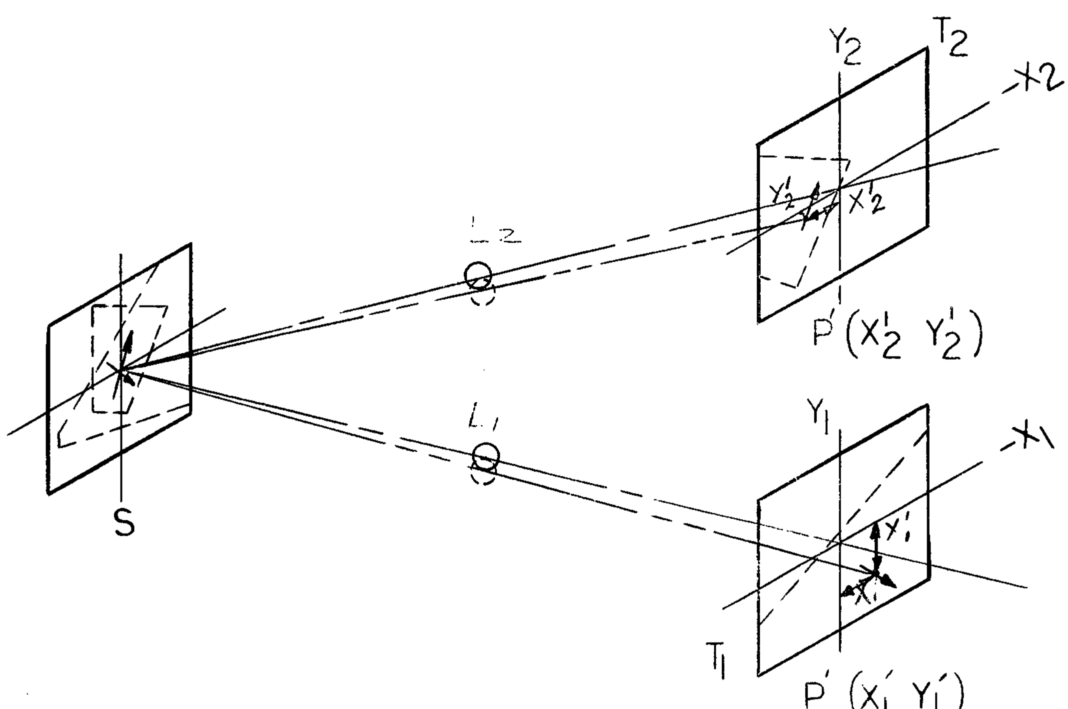

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FIG 2B

SYSTEM AFTER TRANSLATIONAL REGISTRATION

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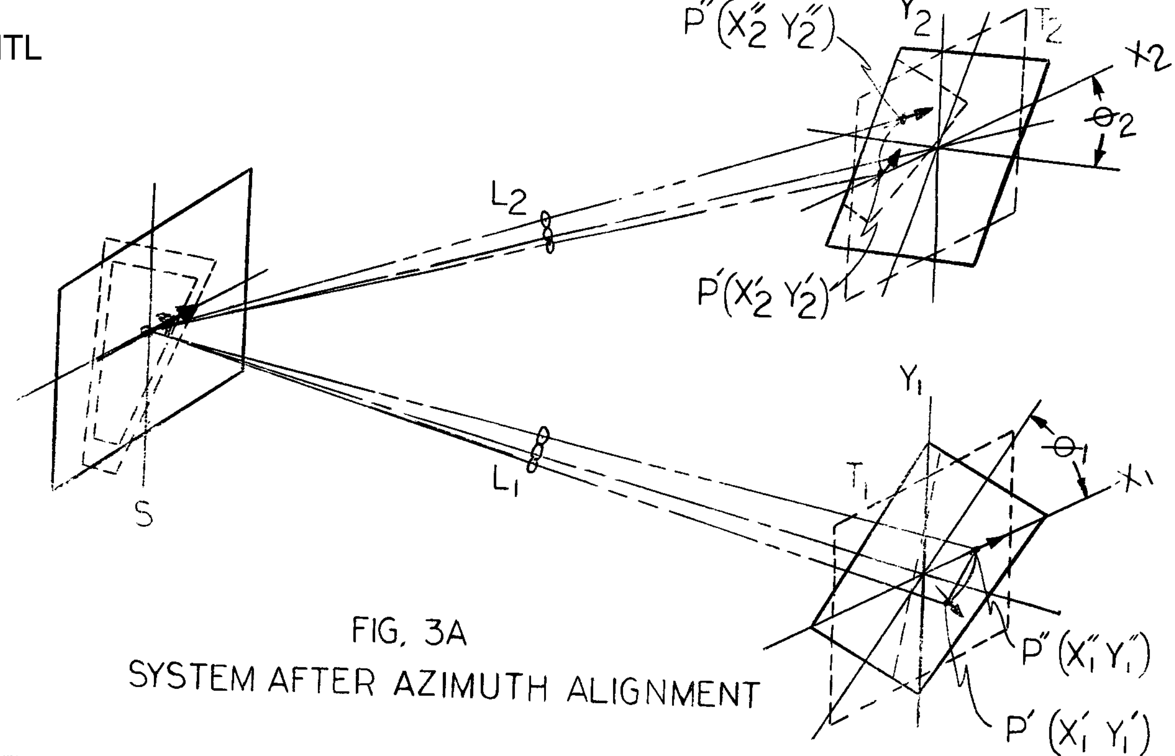

FIG. 3A
SYSTEM AFTER AZIMUTH ALIGNMENT

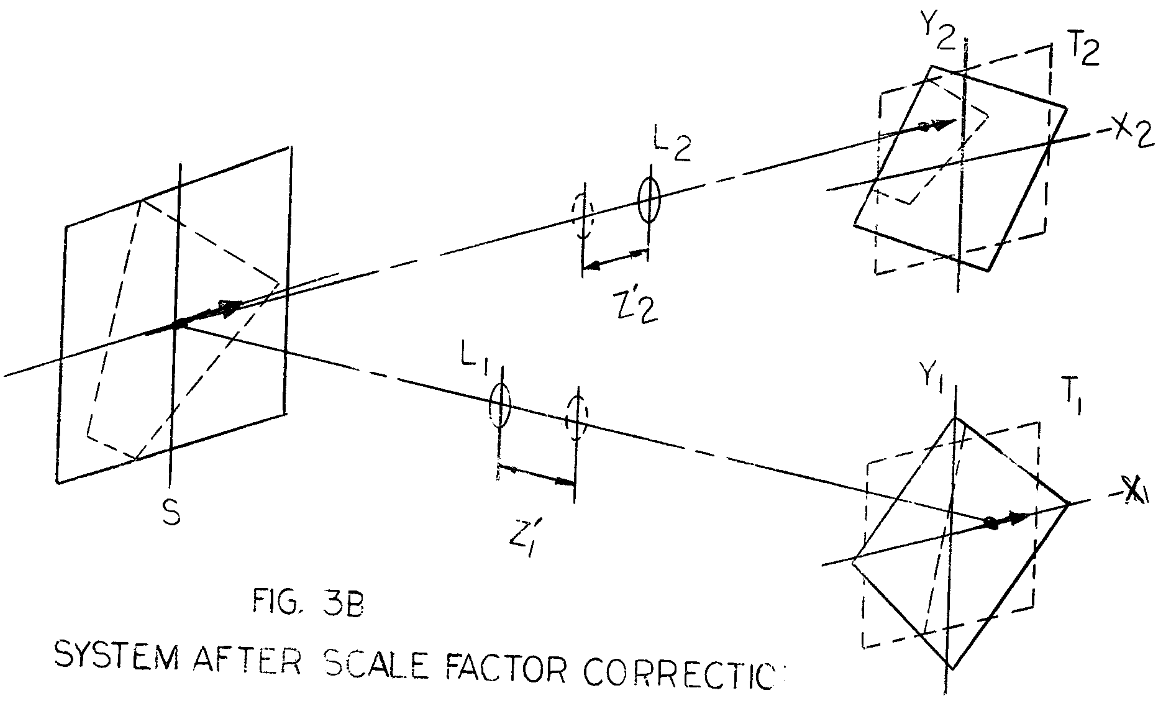

FIG. 3B
SYSTEM AFTER SCALE FACTOR CORRECTIC

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methods of azimuth alignment by insertion of rotational optical elements in the optical path are being investigated but do not appear too promising at this time. Registration in scale factor as shown in Figure 3B requires a translation of the lenses (and transparencies to maintain focus) along the optical path. Initially, lens l_1 is positioned such that the optical center line intersects T_1 at $P''(X_1'', X_1'')$, and l_2 is positioned that its optical center line intersects T_2 at $P''(X_2'', X_2'')$. Lens l_1 is translated axially a distance Z_1' and l_2 translated axially an equal and opposite distance Z_2'. The transparencies follow each lens accordingly to maintain focus. The balanced adjustment of the lenses is used to limit the excursion necessary to obtain the 2:1 variation requirements in scale factor if only one lens were used. X and Y translation of the image at the screen plane as the scale factor is corrected, is no longer a problem with this implementation since the centroid of the overlapping area coincides with the center lines of the optical system. The resultant image registered in X,Y, azimuth and scale factor is shown at the screen, S, in the figure.

To sum up, the requirements for complete registration of the two scenes with an optical path emanating from the center of the screen or CRT surface are:

(1) Translational registration requires lateral and longitudinal excursions of the optical paths at their intersections with the transparency planes.

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(2) Azimuth registration can be accomplished by a rotation of the transparencies but the optical paths must also be rotated along with the transparencies to prevent translation of the image.

(3) Scale factor registration can be accomplished by axial excursions of the lenses and transparencies along the optical paths when the optical center lines of each half of the system intersect the centroid of their respective overlap area on the transparencies.

An implementation which lends itself readily to these requirements is to affix the optical elements to rigid rods which can duplicate the excursion requirements of the optical paths. Obviously, the rods cannot be inserted in the optical paths. They can, however, run parallel to the optical paths with the lenses and other optical elements driven by them so as to be in the proper optical position. With one end of the rods attached to pivot points along side of the CRT, the other end of the rods can be then coupled through mechanical linkages to the control panel for translational variations. Azimuth variations can be accomplished by rotation of the transparencies either through the use of positional servos or mechanical linkages to the control panel. The rods can be tied through mechanical linkages to the rotation mechanism to prevent the translational variations accompanying azimuth registration. Scale factor accomodations can be accomplished by sliding the lens mechanisms along the rods.

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Mechanization of the search and nutation functions for automatic registration will be the same as that previously described. The search and nutation mechanisms will be tied to one of the rods and will follow along as the rod is moved.

Future Plans

Efforts will continue on the design phase of the program. Work will be initiated in the area of display data processing studies.

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Progress Letter for Period

August 1, 1962 to September 1, 1962

CHANGE DETECTOR

[redacted]

17 September 1962

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Program Objective

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occured between the times that the imagery was obtained.

Factual Data and Observations

The second month of the program has been devoted to the intermediate phase of the system predesign. Efforts have been concentrated along the lines of the tasks described in the July progress letter.

In connection with the system design task several areas have been covered. A chart describing the condition, state, or operation of each major component in the system as the console is programmed through the various functions starting with the film insertion and ending with the readout of changes, is being developed. Upon completion of this chart a detailed equipment block diagram of the complete system can be readily generated.

A preliminary sketch of the registration mechanisms and optics has been developed to determine the compatibility of the various components required for registration.

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Consideration of larger film formats was initiated during this period. The following cases are being investigated:

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70 mm aperture on 5 in. film

70 mm aperture on 5 and 9 in. film

5 in. aperture for 70 mm and 5 in. films

9 in. aperture for 70 mm, 5 in. and 9 in. films

A method of masking of one scene on the other during correlation is under development. The requirement for the mask size is to inscribe the largest rectangle within the image of this overlap area of one scene on the overlap area of the other scene.

Efforts on the optical system requirements have been concentrated in two main areas. Tests on phototube signal to noise ratio, linearity, and shading are continuing. A method for obtaining dynamic focus of the CRT under any condition of raster size or position during the area blow-up mode of operation is under investigation.

Work on the up-dating of the breadboard system has been concentrated in the output display area. Circuitry to show the change display with all changes having the same polarity is under development. It is felt this will have value for demonstration purposes as well as for evaluation purposes.

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Discussion

Considerable effort has been expended during this period on the determination of compatibility of larger formats with the existing 70 mm design concept.

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A preliminary sketch of a film magazine required to handle 9 in. film with a 70 mm aperture has been generated. One basic problem that has become apparent during this investigation is that since only a small area of each 9 in. film may be viewed at a time (16 separate areas must be scanned to get complete 9 in. coverage with a 70 mm aperture) the operator may find it extremely difficult to determine the overlapping areas of the two films in order to perform the initial alignment. Offering the capability of viewing the complete 9 in. formats to establish initial alignment but not registering or detecting changes on the total area would appear to be a partial solution to this problem. However, to perform this, either another duplicate optical system with 9 in. viewing capability must be added to the existing 70 mm registration optics, or the existing optical system must be made capable of viewing the 9 in. format. Neither approach can be considered to be very compatible with the existing design concept.

The case of a 5 in. format with a 70 mm aperture exhibits to a lesser degree the problems previously described. Viewing the 5 in. format and registering in 70 mm increments would still require the same type of duplicate optical system presenting the same design problems.

An approach which is currently being considered as a reasonable compromise for this first model is the use of the existing registration optics design concept with a 5 in. aperture to cover 5 in. and 70 mm formats. Large condensing lenses to cover a 5 in. format have been ordered and will be

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used to evaluate the distortion, shading, and resolution capabilities of the Pro-Raptar objective lenses for the larger format. The effects of the large scale factor change and X & Y excursion changes on the registration design concept when going from 70 mm to 5 in. formats are yet to be determined.

Correlation Mask

The correlation mask is used to limit the area of the backlighted scene imaged on the second scene so that only the overlapping areas are correlated during the registration process. The extent of the overlapping area is determined by the relative sizes of the scenes, the displacement of the scenes vertically and horizontally, the orientation of the scenes, and the magnification ratio of the optics.

The correlation mask will be constructed of four movable slides placed at the field lens aperture so that the opening between the slides projects a rectangular masked image of the backlighted scene onto the second scene. The position of the four slides and therefore the mask size, is determined by a "mask computer" mechanism. The "mask computer" which determines the overlap area of the two scenes and feeds this information into the mask accepts inputs from the lens positions and orientations of the two scenes. It is anticipated that mechanical linkages will drive the correlation mask from the output of the "mask computer".

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Automatic adjustment of the raster size on the CRT to view only the area where the scenes overlap will be accomplished by essentially the same method with the exception that instead of inscribing a rectangle of maximum dimension the unit will circumscribe a rectangle that has the same proportions as the raster. The output of this mechanism will be in the form of a potentiometer reading for the horizontal and vertical scan size control.

Dynamic Focus

Dynamic Focus to be used in the system will consist of a correction voltage superimposed on the focus electrode voltage of the high resolution CRT.

An attempt will be made to hold the trace resolution to within 20% of the nominal trace width (.001 inch) over the useable areas of the CRT face. The equation $V = 39\ D^2$ in which D is distance from screen center and V is the correction voltage required to maintain focus when the CRT anode is at 15 KV approximates the required function. A block diagram of the dynamic focus system is shown in Figure 1.

Since a raster of variable size and variable amounts of DC centering offset is to be displayed on the CRT it is necessary to sample both X and Y sweep currents in addition to the X and Y offset currents in the deflection yoke.

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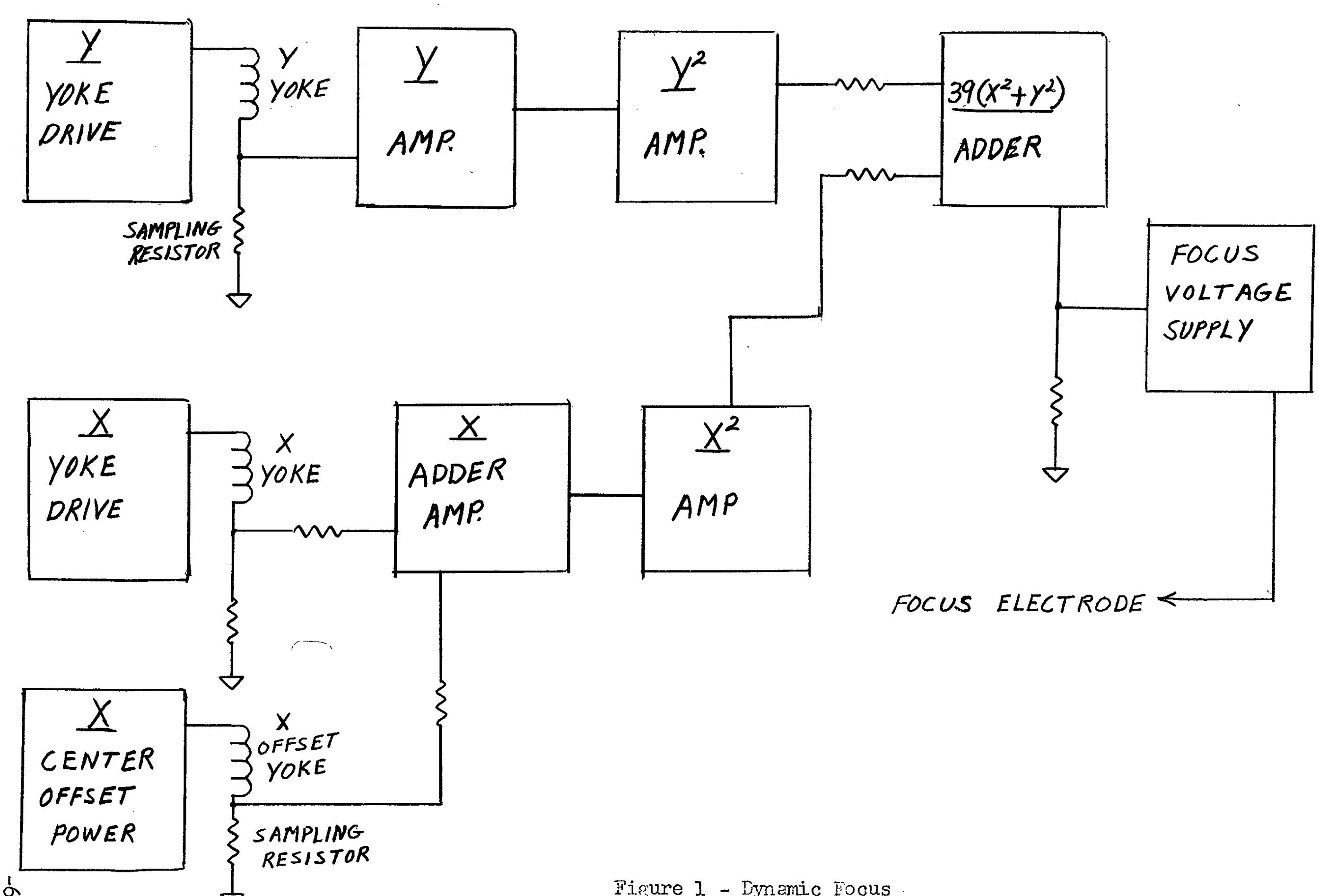

Figure 1 - Dynamic Focus

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The sum of these currents will then be used to derive the focus correction voltage.

No attempt has been made to breadboard these circuits since design work is still in progress on the "X" offset yoke. Some difficulty is expected in the non-linear squaring amplifiers since these must be of the DC type due to the DC offset voltages.

The best approach however, seems to be in finding a triode vacuum tube whose grid voltage vs plate current characteristics approximate the $V = 39\ D^2$ curve.

Future Plans

It is anticipated that most of the system predesign tasks will be completed during the next month. Work on the System Design task will be initiated.

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PROGRESS LETTER FOR PERIOD

JULY 1, 1962 TO AUGUST 1, 1962

CHANGE DETECTOR

[redacted]

10 August 1962

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Program Objective

The purpose of this program is to develop and fabricate a change detector that will compare two sets of imagery taken of the same geographic area at different times and will display and locate any changes that occured between the times that the imagery was obtained.

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Factual Data and Observations

This first month of the contract has been devoted to the initial phase of the System predesign as outlined in the proposed development program of

STATINTL [redacted] In order to adequately perform the design of the change detector console several tasks to be performed in the system predesign phase have been determined. A list of these tasks is herein presented:

1. Determine the complete system configuration most capable of meeting system design goals.
   a. Determine actions and interactions of the following:
      1. X & Y search, nutation and position
      2. Scale-factor nutation and position
      3. Azimuth motion
      4. Tip and tilt excursions
2. Consider the compatibility of the system with film formats through 9 in. (70 mm coverage at one time).
3. Determine the method of scene masking most capable of handling various amounts of scene overlap.
   a. Establish minimum overlap capability.
4. Determine optical system requirements with respect to resolution, shading, distortion, and video signal-to-noise.
   a. Select lenses capable of meeting above requirements.
   b. Select crt and phototubes most compatible with signal-to-noise and resolution requirements.

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5. Select best method of change position readout.
6. Update existing breadboard change detector for use in component evaluation and display data processing studies.
7. Generate design specifications or characteristics for each major electronic, mechanical, or optical component or assembly in both the comparator unit and display unit.

Discussion

Consideration of the complete system requirements has led to the development of two preliminary system block diagrams. They are shown in Figure 1 and Figure 2. The automatic registration mode and the comparison readout mode operations of the system are treated separately since the functions performed by the components of the system are somewhat different in each.

In the automatic registration mode, light from the backlight source will be reflected off the backlight mirror and through the film plane A. The light is then reflected off another mirror in order to fold the optical path. The optical path has been folded to reduce the over-all length of the system in one dimension. This will permit the two film magazine assemblies to be placed in a position in the console where they can be loaded easily. After being reflected off this mirror, the light then passes through one of the objective lenses and is reflected off the removable mirror up to the field lens-mirror reflecting mechanism. The field lens-mirror reflecting mechansim is placed at the same optical position as the crt when the mirror is removed. The light is then reflected again off the removable mirror and passes through the second objective lens, the X and Y nutation wedges, and

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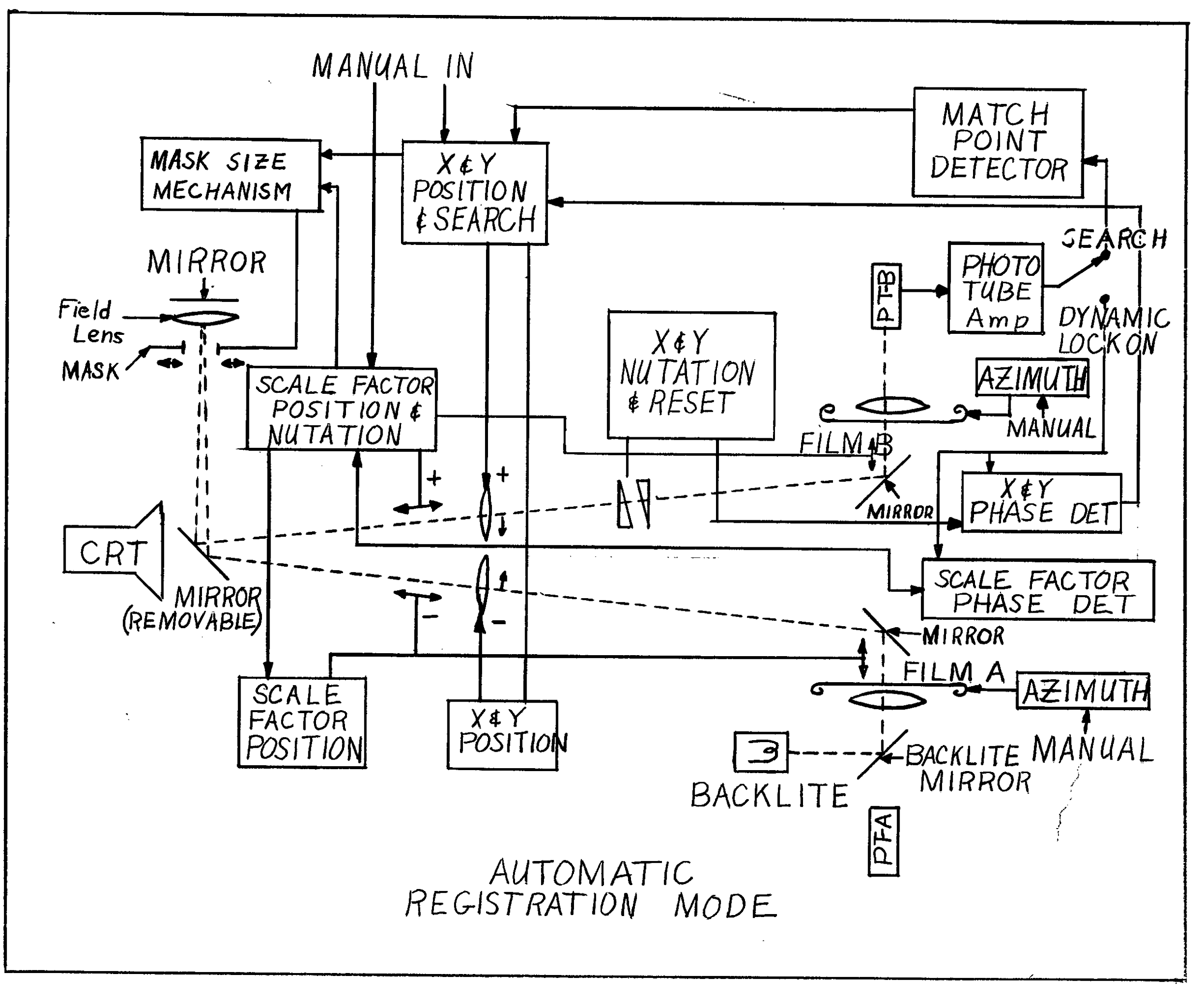

Figure 1

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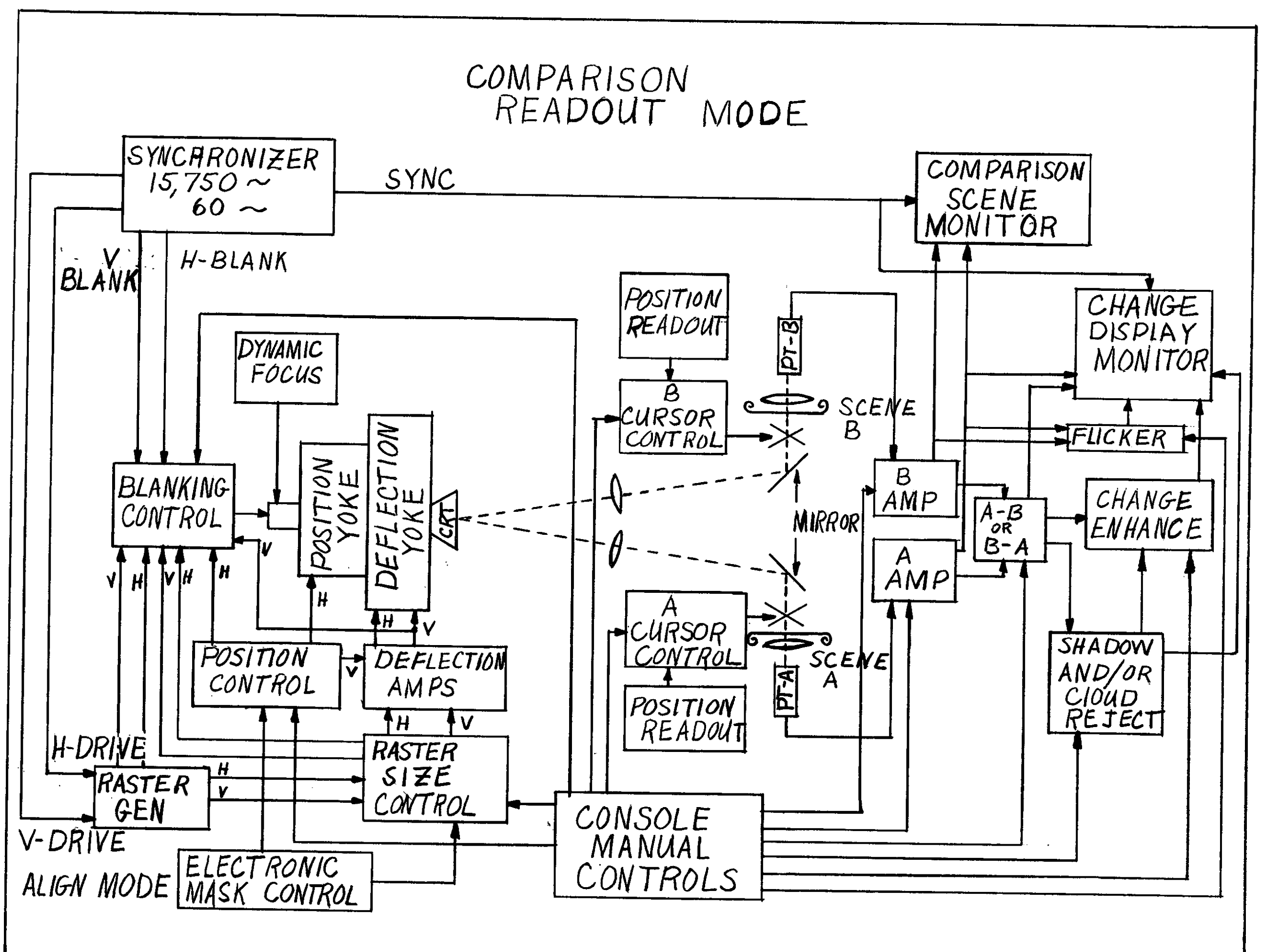

Figure 2

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is reflected off the other folding mirror up to film plane B. The total optical system thus images the scene at film plane A on film plane B. Assuming the same polarity films at both planes the phototube at scene B will measure a maximum of light when the two scenes are in register.

The electronics following the phototube are conventional correlator electronics with match point detection circuitry supplying positional information to the X and Y servos during the search mode and phase detectors supplying positional information during dynamic lock-on. X and Y search will be accomplished by translation of both objective lenses. X and Y nutation will be accomplished with the use of optical wedges in optical path B. Once registration has occured the nutation wedges will be reset to a zero deflection condition so that no deflection of the image occurs during the readout mode. Scale factor position will be accomplished by axial translation of the objective lenses and film planes. Nutation in scale factor will be an axial translation of one of the lenses and scene planes. Azimuth variations will be corrected by rotation of the film planes.

The film mask has been inserted in front of the field lens-mirror reflecting mechanism. As can be noted the two objective lenses move in equal and opposite directions to accommodate scale-factor and positional variations of the two scenes. Thus the optical center of the system at the field lens mirror plane will be held to the centroid of the over-lap area of the two scenes. With the mask inserted at this point only the mask size needs to be varied and not the position. The effect of azimuth variations on the masking and registration problems are still being evaluated.

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Once the two scenes have been registered the system block diagram becomes that shown in the comparison readout mode. Many of the units in this figure have been previously described. Several new units have been included to meet the system requirements. Dynamic focus of the crt will be employed in order to keep the scenes on the monitors in focus regardless of the crt raster size and position.

An electronic mask control in conjunction with a blanking control will enable the operator to view on the monitors only the area where the two photographs overlap regardless of the condition and type of overlap encountered. This unit canbe disabled at the discretion of the operator.

Work on determining the compatability of the system with 70 mm coverage on film formats through 9 in. is in the initial phase.

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Tests on the breadboard change detector have determined that [redacted] 190 mm [redacted] lenses should be adequate to meet the resolution, distortion, and shading requirements of the system. With identical scenes inserted in the breadboard and the system properly aligned excellent cancellation with no measurable distortion or shading effects was observed on the change display monitor.

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A [redacted] 5 in. high resolution cathode ray tube has been selected. This tube has a .001 in. spot diameter and a very fine grained phosphor. It should be adequate to meet the resolution and noise requirements.

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Several photomultiplier tubes and associated circuitry are being evaluated in order to select the components which will produce the best video signal-to

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noise ratio.

Movable crosshairs at each film plane appear to be the best method of determining the change position readout. Inserting these reticles at each film plane will enable a direct measurement from the reference points on the respective films to be made regardless of the scale-factor, relative position, or orientation of the films. Either or both of the crosshairs can be placed out of the viewing area of the monitors when desired. Positional information from the reticles can be fed directly to a digital-type recorder.

Modification of the existing breadboard change detector for use on the program is approximately 90% complete. Most of the system electronics have been rack mounted for accessability. The [redacted] lenses have been mounted and aligned.

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Detailed design specifications and characteristics of all of the major components and assemblies have been initiated.

Future Plans

Efforts during the next month will be concentrated on carrying to completion the seven (7) tasks previously described. Special emphasis will be given to the 9 in. format case.

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